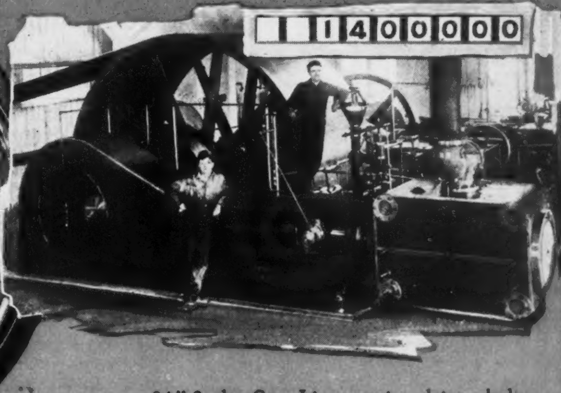
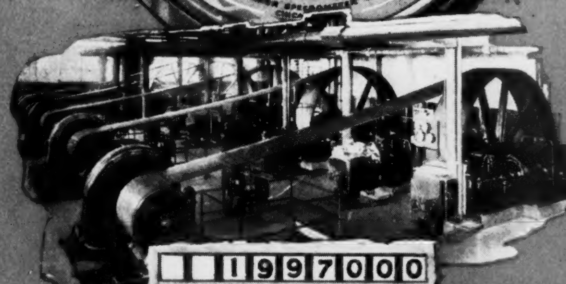
The Automotive Industry and the Machine Tool Builder

OCTOBER, 1924

MACHINERY



One of two 72"-3-ply Reliance belts in the mill of the Oklahoma Portland Cement Company at Ada, Oklahoma. One transmits an average of 850 h. p. and was installed in 1907. The other transmits 1000 h. p. and was installed in 1912. Both are running today. Together they have traveled between 2,500,000 and 3,000,000 miles.



84"-3-ply Sea Lion main drive belt of the Puget Sound Mill & Timber Company at Port Angeles, Washington. Transmits 3,000 h. p. Has traveled well over 1,400,000 miles—still running. Installed 1914.

A row of Reliance 3-ply belts on the compressors of the United States Cold Storage Company, Chicago. The first two belts are 42" wide and each has traveled approximately 2,000,000 miles. Still running.

Million mile belts

made by the pretested method

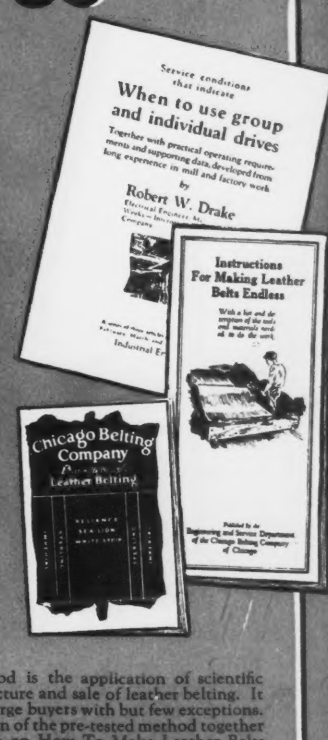
Mileage of a million or two is an ordinary performance for pre-tested Reliance belts. Automobiles do well to go 50,000 miles without over-hauling—and 300,000 miles is about the maximum life of the best cars. Chicago Belting Company belts on any well designed drive deliver from a million to three million miles with but little attention.

Three such installations are pictured but there are in service today thousands and thousands of pre-tested Reliance belts that are giving an equal or greater mileage. They travel at speeds of from 30 to 60 miles per hour and keep it up for years.

It is no wonder that such mileage—such service records—demonstrates to the satisfaction of any management that leather belts *made by the pre-tested method* are at once the best and most economical to use.

If you could but go through our main plant here in Chicago and see how we are applying the use of belt tests and scientific ratings and in-spections, you would readily see how our pre-tested methods are pro-ducing a new and higher quality of leather belting.

You can investigate this new idea without the slightest obligation to purchase. A request for these booklets will acquaint you with the entire story--an interesting and valuable story to all who operate machine shops.



The pre-tested method is the application of scientific testing to the manufacture and sale of leather belting. It is being adopted by large buyers with but few exceptions. A complete description of the pre-tested method together with a practical book on How To Make Leather Belts Endless and Robert Drakes celebrated article on When to Use Group Drives sent to any reader of Machinery magazine on request.

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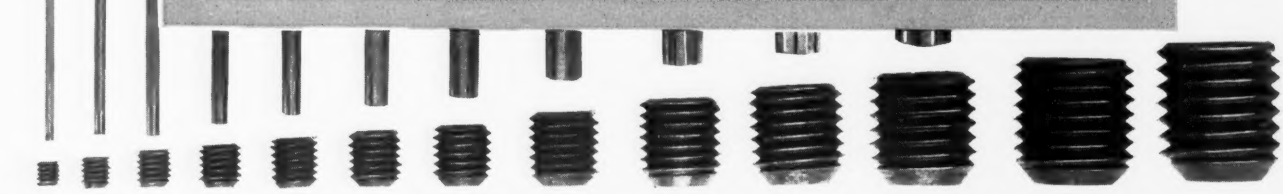

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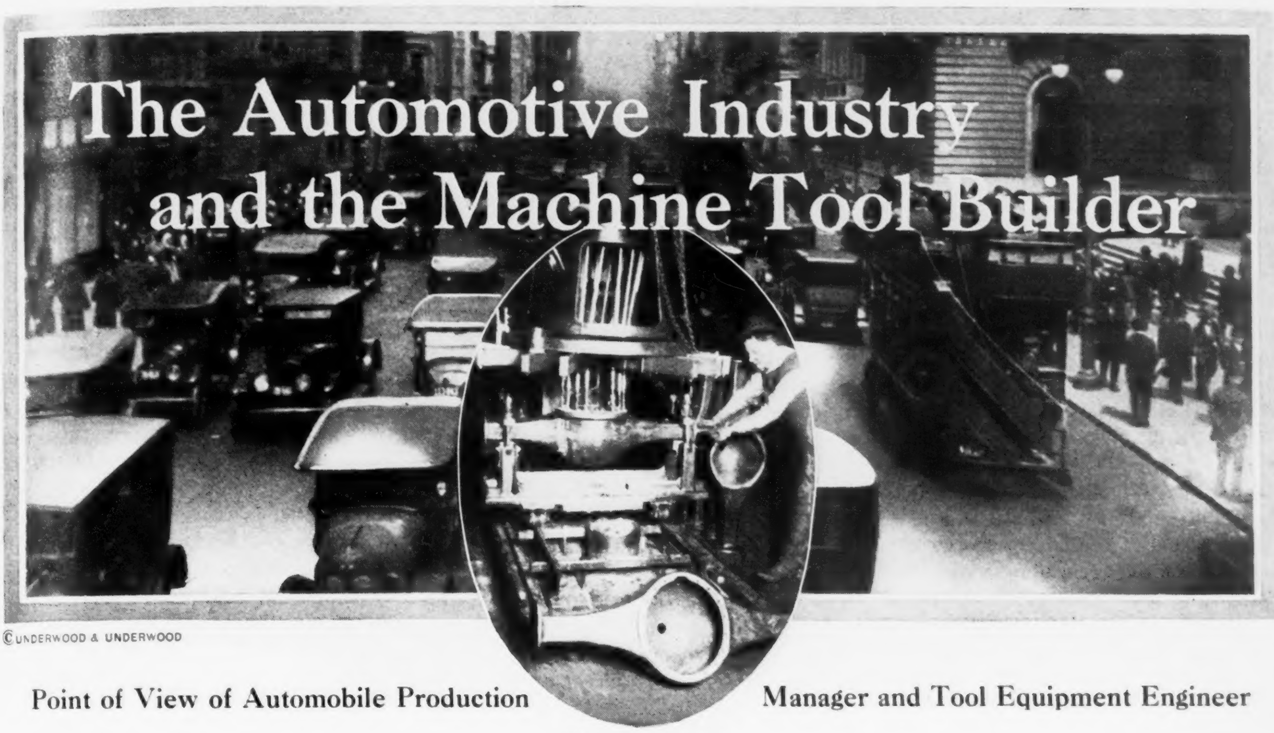

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Point of View of Automobile Production Manager and Tool Equipment Engineer

First Article

THE automotive industry has provided a remarkable opportunity for the development of modern machine tools during the last fifteen years. No one will deny that many of the most important developments in the machine tool field have been due entirely to the needs of the automotive industry; and the art of building machine tools would certainly not have reached its present stage had it not been for the unusual conditions incident to automobile production.

On the other hand, the automobile industry could not possibly have reached its present development except for the high-production machine tools with which the machine tool builder has met the demands placed upon him. The medium and low-priced automobile, especially, is a direct result of improved machine shop equipment, because, were it not for the possibility to produce cheaply in great quantities, the prices at which the lower priced cars are sold would have been impossible.

The automotive and the machine tool industries, therefore, have much in common. Each has developed because of the existence, and through the assistance, of the other. In general, there has been a spirit of friendly cooperation between the two industries, and in many cases the automobile shop has been the laboratory in which the machine tool builder has tried out ideas in the design of entirely new machines. The criticism of the automobile engineer has been very helpful in eliminating weaknesses and defects in new designs and in adapting older designs to production requirements.

With a view to aiding still further in this cooperative work, MACHINERY has undertaken to obtain from production managers and equipment and tool engineers in the automotive industry, such suggestions for the improvement of existing machine tool equipment as might prove helpful to the machine tool designer. From the machine tool builder, also, have been collected ideas as to how the automotive industry can best take advantage of the services rendered by the machine tool industry; these ideas will be placed on record in a subsequent article in this series. Many of the suggestions received from both sources are very definite, and it is believed that both the automotive and the machine tool industries will be aided by this review of the conditions.

Single-purpose versus Standard Machines

The question that seems to be uppermost in the minds of all equipment engineers in the automotive shops is whether single-purpose or standard machines should be used. It may be stated at the outset that the present tendency in most of the automobile plants is away from the single-purpose machine. This does not mean that the regular standard machine fully meets the requirements. There is a need for a special type of production machine tool, of which only a few have so far been developed. This production machine tool, of which the automatic milling machine may be cited as an example, should be considered a standard machine tool for industries where high production of similar parts is required, as in the automobile industry. It is only in a few of the plants, where the production runs into thousands of cars a week, that the wholly single-purpose machine is considered an unqualified success. In most of the other plants, machines are required that, while especially adapted to high production, can be transformed, by a change in the tooling equipment, to adapt them for making similar parts of another car or model.

In the series of articles of which this is the first, are recorded the opinions of automotive plant production managers and equipment engineers on machine tool equipment for production work. The views of leading machine tool builders will also be given. Among the subjects dealt with are a comparison between the fields for the standard and the single-purpose machine, need for production machines built along somewhat different lines from regular standard machine tools, need for new machine tool equipment for production and service shops, suggestions for improvements in the design of machine tools, maintenance problem, methods of selecting machine tools in automotive plants, cooperation between salesmen and production engineers, qualifications of salesmen and purchasing agents, problem of production estimates, and, in conclusion, the automotive engineer's very frank and definite opinion of the weakest spot in his own industry.

In discussing the subject of single-purpose machines, one equipment engineer pointed out that an accurate analysis is seldom made of whether a completely single-purpose machine built to order will pay. "As a rule," he stated, "the total manufacturing cost is greater on these single-purpose machines than on properly tooled standard machines, the exceptions being in shops where production is unusually high. In one case, a single-purpose machine was used on axle housings where the interest on the investment in the machine alone was four cents per axle housing. This did not take into account depreciation or operating costs. In another case, a special machine requiring a great deal of experimental and development work was built at a cost of nearly $100,000, the main advantage of this equipment being that it could be attended to by one operator. Four standard machine tools at a total first cost of $20,000, employing two operators, would have performed the same work with the same rate of production. The advantage gained was the saving of the wages of one operator and some floor space; but with a difference of capital investment of nearly $80,000, it does not require a great deal of figuring to find that it would take a long time for the operator's wages to equal this additional investment. In fact, the interest alone on the difference would pay the wages of at least two operators year after year."

This may have been quoted as an extreme example, and in no way applies to the special machines that are being built regularly for high production of single parts, but that, with a change in the tooling equipment, can be equally well adapted to the machining of any other parts of similar size and design. Such machines are often called single-purpose machines, though they should more properly be termed "special machines."

The present tendency in most of the automobile plants is away from the strictly single-purpose machine. This does not mean that the regular standard machine tool fully meets all the requirements. There is a need for new types of production machine tools of which only a few have so far been developed. These production machine tools would be a new type of standard machine for industries in which high production of similar parts is required —machines that would combine the best features of the present standard and single-purpose types of machines.

Where Single-purpose Machines are Preferred

No rule is without exceptions. It is generally agreed that wherever the production warrants, single-purpose gear-cutting machines are advantageous. In the single-purpose machine it is possible to avoid numerous sliding joints and gear combinations, and therefore these machines, all other factors being equal, are more accurate than the more universal machines. There is a definite need for single-purpose machines of this type in the automotive industry, and those that have been developed so far are highly spoken of.

Machine equipment for finishing cylinder blocks by boring, reaming, grinding, or lapping may also be built to advantage as single-purpose machines; and generally speaking, large producers who build 500 cars a day or more, find many uses for the single-purpose type. On the other hand, the production of the single-purpose machine is too great for many plants where the daily output is limited to a comparatively small number of cars. Here the equipment would stand idle a large part of the time, and as it is in these plants that the changes of design are more frequent than in the plants building the largest number of cars per year, there is greater danger that the single-purpose machine will become useless, after a change in the design of the car.

The Need for Simple Standardized Production Machines

In taking issue with the entirely single-purpose machine, most production managers and equipment engineers do not mean to convey the idea that the ordinary standard machine tool meets all requirements. On the other hand, what they have in mind are production machines built along somewhat different lines from the regular standard machine tool. The latter was developed originally for shops where a variety of work was done, and the work that the machine would do might change several times a day. The regular lines of lathes, drilling machines, and milling machines were developed with this type of shop in view; hence, these machines are provided with numerous speed and feed changes and rapid-change gear-boxes, and many other features of value in a shop where a varied line of work is met with.

The production machine that the automotive engineer has in mind is a different type of machine. It is standard in that it may be used for a variety of work of a similar nature, but it is built especially for high production and is limited in its range of speeds and feeds. It has no gear-boxes for rapid changes. If the feeds and speeds should require changing when, after a long period, the machine may be scheduled for a different type of work, then these feed and speed changes, instead of being made through a gear-box, would be made by simple change-gears or pick-off gears, as in the earlier types of lathes. This construction is less expensive, and is conducive to greater accuracy.

These production machines, the equipment engineer believes, can be so developed as to be standard in their general features, but have special attachments or tooling equipment that will adapt them for work on parts of different automobiles. For axle work, for example, it is believed that a machine could be developed that would be standard in its general features and yet adapted to work in different axle plants. In the piston department, highly specialized tooling might be required, yet a standard type of machine could be developed especially for piston work that would be suitable for all classes of pistons. In this connection it might be of interest to note that a high-speed lathe is required for aluminum pistons, which can be most economically turned with diamond tools at very high speed.

The machine tool builder, by studying the needs of the automotive industry in specific instances, such as those mentioned, and by conducting some experiments, when necessary, is enabled to develop the best machine and method for an entire line of automobile parts; and instead of special machines being built for each plant, a standard production machine with specialized tooling could probably be developed to meet the needs. If such systematic studies were made, it is believed that instead of so many special machines being built for different plants, standardized types could be evolved by simply using different fixtures and tooling.

Opinions of Authorities on Single-purpose Machines

In order to show that there is by no means universal agreement as to the present status of the single-purpose machine, the following verbatim quotations are recorded.

The vice-president and production manager of a well-known motor truck concern states: "The present tendency is away from both single-purpose machines and general utility, or fully universal, machines, and toward the simplified standard machines, which are sufficiently flexible to cover a certain class of work, but in actual practice are really used as single-purpose machines."

Another opinion from the truck industry is as follows: "In the truck industry, production has never obtained the volume that the production of pleasure cars has, with the result that standardized machines are more desirable."

From the tractor industry we received the following comment on this question: "I think the present tendency, in so far as the tractor industry is concerned at least, is toward the use of specialized, semi-universal, general utility tools. rather than highly specialized, single-purpose equipment. except in cases where the single-purpose tool of rather simple construction meets the requirements. We have a number of special tools, the majority of which, however, can be converted to other purposes by an investment approximating one-third of their original cost. The remainder of the special equipment is necessary because of the peculiar nature

of the operations. I think our tendency, however, in the future will be toward standard tool equipment in more cases than it has been the case in the past, using only single-purpose equipment where nothing else would be as efficient or economical."

One engineer engaged in truck manufacture states that while the tendency is away from the strictly single-purpose machine, there is an increasing need for further development of fully automatic and semi-automatic machinery, as it is only by the use of such equipment that production costs can be lowered. The semi-automatic heavy chucking machines and milling machines, and automatic turning machines of all types, are, in fact, among the most popular machines in the automotive industry, in addition to the highly specialized automatic machines that have been developed mainly for work in this field.

In this connection, it is well to remember that machines that were considered to be special or single-purpose types twenty years ago are now regarded as standard machines, and that therefore it is likely that many of the so-called "special" machines of today will be the standard machines of tomorrow. The automotive industry is the greatest influence in aiding in this development, and through its needs, the future will doubtless see many new types of what will ultimately become standard machines.

The production machine that the automotive engineer has in mind is a standard machine in that it may be used for a variety of work of similar character, but it is built especially for high production and is limited in its range; for example, it has no gear-boxes for rapid changes, and if the feeds and speeds should require to be changed, when, after a long period of work on one part, the machine is scheduled for a different kind of work, then the feed and speed changes would be made by simple change-gears, in the same way as in the earlier types of lathes.

New Honing Machine Required

Among the many new types of machines suggested as required in the automotive industry may be mentioned, first, a honing or lapping machine for cylinders. Many different suggestions as to the method of operation of such a machine have been made. Some equipment engineers believe that such machines should hone or lap a single cylinder at a time, while others claim that it is possible to obtain satisfactory results by honing all the cylinders at once. Those who prefer the single-cylinder honing method claim that it is difficult to obtain hones of such uniformity that they will all work equally fast, and that when four or six sets of hones are used for a four- or six-cylinder block, some of the sets will cut slightly faster than the others and produce cylinders slightly larger in diameter than the rest. The practice advocated, therefore, by the supporters of the single-cylinder honing method is to time each new hone for the first cylinder that it laps and then permit it to lap each successive cylinder exactly the same length of time. It is claimed that in this way uniformity is assured. Other engineers, however, claim that the difference is not great enough to warrant such extreme precautions.

There is also a difference of opinion as to the kind of movement required in a cylinder honing or lapping machine. The movement now generally advocated is a fairly rapid up and down movement accompanied by a comparatively slight rotary movement of the hones, but it is by no means definitely agreed upon that this is the very best movement. Possibly there should be a more rapid rotary movement accompanied by a slower up and down movement. One engineer advocates mainly a rotary movement, with an oscillating up and down motion, accompanied by a slow continuous downward feed.

The differences in opinion on this subject indicate that there is an opportunity for careful experimental work, and there is doubtless a broad field for a machine that will successfully hone or lap automobile cylinders. The machines now in use in a number of automobile plants have been rigged up by the shop engineers themselves, and many makeshift arrangements are employed, although they give satisfactory service. It is generally agreed that there would be more lapping of cylinders if suitable machines were on the market.

Gear Grinding Machine Developments

Rapid strides have been made in the development of gear grinding machines during recent years, and many of the present designs are highly thought of by equipment engineers. Nevertheless, the art of gear grinding is generally considered to be in its infancy, as it is only a few years ago that the first successful machine for this work was brought out, and it is believed that as the subject of gear grinding becomes more thoroughly understood, improvements in machines and methods will be developed. The special need seems to be for a gear grinding machine that will produce accurate and silent gears more rapidly than the earlier machines. While the development of these machines during the past years are not underestimated, equipment engineers are looking forward to still further developments within the next few years.

Other New Types of Machines Suggested

Among other machines mentioned as having a market are a small jig boring machine for tool-room work; heavy semi-automatic turret machines that will further reduce labor costs and increase production; a machine that will make it possible to grind two pins on crankshafts at once; a machine for facing the inside bearing faces of crankshaft bearings in the crankcase when the caps are assembled in place; a boring-bar for crankcase boring in which there will be less need for change of cutters than is generally necessary at present —in other words, the bar would make use of socalled "disappearing" cutters, so that the time now required for removing and replacing the cutters would be saved (some of the shop men hold that single-pointed cutters would give better results than those cutting with both ends at once); and a machine that will make it possible cheaply to balance crankshafts, flywheels, and clutches. It is admitted that there are good balancing machines now on the market for this purpose, but the automotive engineer, of course, is constantly on the lookout for something that will still further decrease costs.

In one plant, the need of a small portable hardness testing machine that would test materials on the Brinell principle was mentioned as a tool that would prove very useful in the automobile plant, if it were available. Several production managers have suggested that broaching machines will be more generally used when they are all provided with high-speed return strokes and the cutting speed generally increased. There is great promise in the constant improvements that are being made in broaching machines, and many engineers look with favor upon the possible further development of the hydraulic broaching machine.

Generally speaking, however, most of the interest in the development of new equipment centers on gear producing machines—gear-cutting and gear-grinding machines. In spite of the remarkable developments that have been made during the last twenty years, the gear-cutting department is usually considered the weakest spot in the automotive industry, and one that needs improved equipment more than any other.

More Cam-fed Machines Required

Production machine tools could often be advantageously provided with cam feed. In some shops cam feeding arrangements have been provided on the machines by the automobile engineers themselves. The advantages of the cam feed are that it provides a simple means for a quick approach of the cutting tools, an accurate control of the feed while cutting, and a quick return. Furthermore, it is pos-

sible to so arrange a cam feed that the tools are not brought into engagement with the work by a sudden shock, which is one of the greatest causes of dulling and chipping of the cutting edges. Cam feeds should be generally applied to production turning machines of various types, drilling machines, milling machines, and boring machines. In the case of drilling machines, for example, it is possible to enter the work slowly, speed up during the main part of the cut, and to break through the work easily when the hole is completed. In the case of cross-feeding facing cuts, cam feeds can be used to obtain a uniform cutting speed during the entire operation.

Equipment Needed for Service Shops

When it is remembered that there are 70,000 service stations throughout the country, of which about 30,000 are maintained by dealers and 40,000 are independent service and repair shops, most of which are conducted in connection with garages, it will become evident that the equipment for these service shops is no small item. Some of the leading automobile builders have issued booklets recommending certain equipment for service shops. In recommending equipment, they take into consideration simplicity and cost.

Generally, service equipment must be inexpensive, because the average service shop and garage cannot afford to pay for a highly developed and expensive machine. The equipment must also be easy to operate and maintain. The machines especially intended for service shops should not be of a universal type suitable for all kinds of repair work, but should be made especially for automobile repairs. Some machine tool builders have developed equipment especially intended for this service, but on the whole the builder of standard machine tools has not done so much along this line as was necessary to hold the market, and as a result numerous service equipment manufacturers have come into the field, who are supplying the machines, attachments, tools, and devices that are needed in the service shops.

The equipment required by a service shop depends to some extent upon the distance at which it is located from the automobile factories. Wherever it is easy to obtain repair parts quickly, or, if necessary, to send parts to the factory for repairs, there are many operations that the service shop need not perform. On the other hand, service shops located at remote points require a fairly complete machine tool equipment, so that they can undertake any kind of repairs, and, if necessary, make a replacement part for emergency service. Generally speaking, the less expensive types of lathes, drilling machines, and shapers are well suited to service work, in addition to the special grinding machines that have been developed for this field. In many garages that are called upon for emergency work only, some of the multi-purpose machines that have recently been developed will prove of considerable value.

One manager of the service department of a large automobile company points out that the development of service tools and equipment is now at a stage where manufacturing tools were some fifteen years ago, before quantity production became necessary. With fifteen million automobiles in use throughout the country, it is evident that there is a great need for efficient maintenance work and consequently a demand for time-saving tools and methods for handling automobile repair work. The manufacture of production machinery and tools has been very highly developed, but the same systematic and careful thought has not yet been given by the machine tool manufacturer to equipment that would be especially suitable for the automobile service station. A great deal of assistance and cooperation can be rendered the manufacturer who wishes to study this field more thoroughly by the service departments of the larger automobile companies, who are constantly recommending equipment for the use of their authorized service stations.

Suggested Improvements in the Design of Machine Tools

Numerous suggestions for improvement in the design of machine tools have been made by equipment engineers. A number of these improvements have already been incorporated in some types of machines, but they are given here because of their general application, as they will indicate to the machine tool builder the trend of thought of the men responsible for machine tool equipment in these plants.

A valuable feature in all machine tools where the cut is not steady, but intermittent, as in milling machines and gear-cutting machines, is a flywheel. The use of a flywheel reduces chatter, lengthens the life of the milling cutter or hob, and increases the cutting speed at which it is practicable to run the machine.

Quick-return motions should be more generally provided. Quick-acting tailstocks save a great deal of time on machines handling work that has to be removed and replaced frequently.

Among the new machines that have been suggested for special application in the automotive industry is a honing or lapping machine for cylinders. Some equipment engineers think that such a machine should hone or lap a single cylinder at a time, while others state that satisfactory results may be obtained by honing all the cylinders in a block at once. There is also a difference of opinion as to the kind of movement that is required in a cylinder honing or lapping machine; generally a fairly rapid up and down motion accompanied by a relatively slight rotary movement of the hones is advocated.

Improvements are suggested in the indexing mechanisms on all turret machines and other machines that index from station to station, to produce greater smoothness of action and avoid sudden jerks or blows.

Brackets or shelves should be provided on all machine tools for gages, wrenches, hammers, and other tools used about the machine by the operator engaged in production work.

The provision made for chips is often too limited on machines used for production purposes. Ample chip pans should be provided on all machines, and provisions should be made so that the chips will not collect on the work and sliding ways.

Guards should be provided whenever practicable, not only for safety but also to keep chips and dirt away from bearings and bearing surfaces. In providing guards for machine tools, the manufacturer must study the laws of different states. Ohio is especially strict in this respect. Most buyers of machine tools in that state have, themselves, to place many belt guards on the machines after they have been installed.

The frames of many machine tools are too light for the heavy duty imposed upon them in production work. The ordinary type of upright drilling machines, for example, when used for heavy-duty drilling, need firmer columns and braces in the back than is generally provided, to prevent springing of the frame, insure straight holes, and minimize drill breakage.

In designing machine tools for production work, thought should especially be given to the amount of effort required to place heavy parts on the table of the machine or in the jigs and fixtures. In one case, a crankshaft grinding machine was provided with a steadyrest that necessitated lifting the crankshaft over the steadyrest when placing the work in the machine. This made the operation of the machine very heavy and laborious. A change in the arrangement greatly facilitated the work and speeded up production.

The height of the tables of many machines is too great for production work. Generally speaking, the top surface of the table should not be over 28 inches from the floor; this will fit the most suitable height of a conveyor system, reduce fatigue on the part of the operator, and sometimes make it possible for one man to operate a machine that would otherwise require two men, simply because the parts are too heavy for one man to lift to the height necessary. As a result of high machine tables, it has sometimes been

necessary to place a strong, husky man in operation of the machine, when he was not otherwise fitted for the work, because a man with less muscular power would have been unable to do the heavy lifting necessary throughout the day. In some cases loading tables can be provided in front of station type machines so that the work can be slid directly from the loading table into the jig or fixture of the machine.

One equipment engineer says: "The cross-slides of many machine tools are too narrow to support the tools properly. Two machine tool manufacturers of my acquaintance recently admitted this fact and changed their slides accordingly. The life of the cutting tool between grindings depends largely upon the design and construction of the machine tool itself, and the economy of using maximum feeds and speeds depends, in turn, upon the life of the tools; hence rigidity in the machine tool is of importance for economical production."

It has been suggested that all machine tools should be painted a uniform color; as it is now, machine tools from different manufacturers come into the plants without any uniformity as to appearance. This suggestion would be of greater value, if the users of machine tools, and especially the large automobile builders, could agree upon a certain color. One of the largest builders of automobiles requires a certain color for his plant, and certain other automobile builders also specify how the machines are to be painted; but the specifications are not uniform. Hence, the machine tool builders can hardly do anything in the way of standardizing on machine tool colors.

Cam feeds could often be used to advantage on production machine tools in the automotive plant. In some shops cam feeding arrangements have been provided on many machines by the automobile companies themselves. The advantages claimed for the cam feed are that it provides a simple means for a quick approach of the cutting tools, an accurate control of the feed while cutting, and a quick return. Furthermore, a cam feed can be so arranged that the tools are not brought into engagement with the work by a sudden shock which causes rapid dulling and chipping of the cutting edges.

Suggestions for Lathe-Type Machines

On lathe-type machines there is generally a need for hardened steel ways to prevent the cooling compound and the chips from too rapidly lapping away the soft cast-iron ways. More abundant chip pans are required in some cases. Heavy ball-bearing tail-centers are of great advantage when heavy cuts are taken. The center should revolve, because the localized pressure on a small portion of a stationary center causes an undue amount of wear. With a big revolving center this difficulty is obviated. In one large plant, all lathes used for heavy work have been provided with such centers, and the results are stated to have been very satisfactory.

Generally speaking, the spindle bearings are not large enough for the heavy cuts possible with the newer high-productive cutting alloys. The drive is sometimes too far away from the spindle nose, and the machine, as a whole, is not always massive enough for production work. On the newer types of turning machines of all classes, the head is often much heavier and stronger than the rest of the machine, and if the whole machine were designed in proportion to the head it would be far superior as a heavy-duty machine.

For production work, lathes without gear-boxes and without many of the features of the modern engine lathe would serve the purpose better than the ordinary engine lathe. Such a production lathe would be of quite a simple design and would have comparatively few speeds and feeds, and these might be obtainable by the use of change-gears rather than a gear-box. It would need no provision for thread cutting, as it would be simply a turning machine.

Suggestions for Drilling Machine Design

Drilling machines of every type ought to have ball bearings on every shaft that rotates constantly. The motor drive ought to be built into the machine, and an induction type motor should be used, as such a motor will permit 100 per cent overload for short periods. A built-in motor drive can be cheaply incorporated in the original design, and in this way the machine can be placed in any convenient position independently of other machines.

Great strides have been made in the development of good tapping attachments in recent years; yet it is believed that still further improvements in this direction are possible.

Flywheels on heavy-duty drilling machines would be likely to steady the cut, and in drilling some materials would help to save the drills.

Drilling machines provided with turrets which will permit the operator to use one tool after another without the use of quick-change collets are of considerable advantage in production work, and could be used more generally than they are. With these machines, the tools are always in place, and by merely indexing the turret, an unskilled operator can produce work much faster than when the tools, and sometimes the collets, have to be changed for each operation.

One equipment engineer makes the following suggestion: "I think that the drilling machine manufacturer could do a timely service to the automobile industry by developing a special-purpose machine, the main features of which could be standardized, for drilling front axles where the brakes are assembled to them. All front axles fitted with brakes have an inclined king-pin. The inclination or angle of the king-pin differs in almost every car, and it is possible that a machine could be developed of the planer cross-rail type, with long sliding ways, having sliding adjustable spindle heads at each end, and a graduated adjustment reading in degrees to take care of any angle necessary. In the middle of the cross-rail there could be mounted one spindle with a multiple head attachment, and a single spindle for general purposes, so that when the machine was not used for angle drilling or reaming, other work could be performed as well. A machine of this type could do all drilling operations on the front axle in one set-up. Such machines may have already been developed specially for some automobile manufacturers."

Suggestions for Milling Machine Design

The spindle construction of milling machines for production work must be unusually heavy. Even a spindle that is strong enough for the uniform resistance placed upon it by a steady cut is likely to be too weak when the machine is used on interrupted cuts. It is not mere strength in the spindle that is required, but it must be heavy enough so that there is practically no torsional deflection under a heavy cut. If there is such deflection, the spindle acts practically as a torsion spring and the cutter will chatter. The part of the spindle that enters the driving gear should be larger in diameter than is commonly the case, especially on machines intended for production work. One equipment engineer believes that even if the spindles were made from a cheaper material, they would give better results if they were much larger in diameter.

Other suggestions in connection with milling machines are as follows:

The drive should be arranged to be just as close to the nose of the spindle as possible.

Flywheels should be provided on all milling machines. In some plants machines have been so provided, and in this way trouble from chatter has been avoided, and the cutters have been found to last much longer; nothing spoils the edge of the cutter more quickly than the effect of chatter. On hand millers, especially, flywheels are of great value, and in one plant every hand miller is so equipped.

For production work, the table of heavy knee-type millers is too high. In some cases platforms have had to be built for the operator.

More provision for chips is required on most milling machines, and more generous provision for cooling compound is also needed. On some machines the improvements listed have already been provided for, but the suggestions refer to the general line of machines.

Suggestions Relating to Grinding Machines

Grinding machines, more perhaps than any other machine tools, need to be unusually rigid and massive. Large heavy bearings are required to eliminate vibrations. The productivity of a grinding machine depends largely on this one factor. There are some machines that are of unusually good design as far as their operating features are concerned, but that are too light for the kind of production work required in automotive shops.

Automatic sizing attachments for grinding machines are probably capable of still further developments. There are several good sizing attachments now available, but the automotive industry is looking toward their more general application, and it is considered one of the very important developments in the grinding machine field.

The finishing of two diameters simultaneously by grinding is expected to be one of the coming developments.

In the opinions of some equipment engineers, grinding machinery is probably capable of the most conspicuous improvement in the machine tool field, the centerless grinder being noted as the most outstanding example of what can be done through an original design to reduce manufacturing costs.

Centerless grinding has been greatly developed in the last few years, and has proved a valuable adjunct in automobile production work. Without doubt this method of grinding will be still further developed to be applicable to many classes of work for which it is not now generally used.

In one automobile plant where 600 machine tools are in use, every machine has been provided with piping, allowing a liberal amount of cooling lubricant. The lubricant is automatically turned on before the tools begin to cut, and the automatic feed is thrown in before the tools reach the work, to prevent the tools from suddenly coming into contact with the work with a shock. Through the means adopted, the tool cost was reduced and the production in the plant increased to such an extent that $17,000 was saved a month in labor costs. This is equivalent to about $1.15 per machine per working day.

Provisions for Motor Drive

Several automobile plants are now motor-driven throughout, and for that reason all machine tools ought to be provided with a pad for a bracket on which the motor could be applied in case motor drive is desired. The absence of such a pad sometimes makes it rather difficult to mount motors on machine tools that were originally built for belt drive. The actual brackets themselves, on which the motor would be mounted, could hardly be provided until there has been a standardization of motors for machine tools.

The question of individual motor drive or group drive is one that has not yet been settled in all automobile plants, the same well-known arguments being presented—on the one hand, that the group drive is cheaper in first cost and in maintenance cost, and on the other, that when individual motor drive is used motor trouble does not put half a dozen or more production machines out of work; furthermore, if a single machine only is to be operated, it is cheaper to run it alone than to have the lineshafting and countershafting for a number of machines running also. Certainly, no general rule can be laid down as to which method is more economical, since this depends mainly upon plant conditions; but all are in agreement that machine tools should be provided with means for attaching electric motors if desired.

Lubrication of Machine Tools

Practically all machine tools should be provided with flood lubrication, retaining means being provided so as to prevent the oil from leaking all over the machine. This has been successfully done in automobiles, and therefore it can certainly be done in machine tools. Automobiles operate at a high speed and yet, with pressure lubrication, there is no appreciable lubricant leakage. Machine tool gear-boxes are generally well enclosed, but leakages almost always occur around the bearings.

Sometimes the lubricating means are in themselves satisfactorily arranged, but the amount of lubricant conveyed to bearing surfaces and gear-boxes is insufficient. Still more often, however, insufficient lubrication is due to neglect on the part of the operator, resulting in short life of the machine and loss of production, from which the reputation of the machine tool builder often suffers, although he is in no way to blame.

At the annual meeting of the Society of Automotive Engineers in Detroit last January, a paper was read by Thomas Nadin, general superintendent of the Rolls-Royce Co. of America relating to the need for improved lubrication means in machine tools used in automobile shops. This paper was printed in the February number of the Journal of the Society of Automotive Engineers, and is worthy of study by every machine tool builder. The lubrication system would be greatly improved if it could be so arranged that, in addition to providing for ample lubrication, it could be made practically fool-proof in the hands of an inexperienced or a careless operator.

Another production engineer makes the following statement: "I believe that the greatest difficulty with ordinary machine tools is due to the lack of adequate automatic lubrication, coupled with ineffective methods for excluding dust, chips, and cutting compound from rotary or flat bearing surfaces. The piece-worker of today does not tend his machine with the friendly feelings of the old-time mechanic. His motto is to get everything out of the machine that is in it, and to get everything out of the tools that they will stand. It is rather the exception than the rule, therefore, to find a machine tool, unless it has been specially built for high-production work, that possesses sufficient rigidity and is so well provided with means for lubrication that the limit of production is in the cutting tool itself, which it naturally should be."

Control of the Cutting Lubricant

The cooling or cutting lubricant ought to be automatically controlled. There are machines on the market in which it is, but it would be of great advantage if this method were more generally applied. The cooling compound should begin to flow as soon as the machine is started. It should stop when the machine is stopped. Big pipes should be provided to insure a generous volume of cooling compound. In one automobile plant where six hundred machine tools are in use, every machine has been provided with piping that increased the flow of the cooling lubricant, and arrangements have been made so that the lubricant will always be turned on before the tools begin to cut. In addition provisions are made so that the automatic feed will always start before the tools reach the work, to prevent the hand feeding from suddenly bringing the tools into contact with the work. In this way the tools were saved from damage at the beginning of the cut, which is the time when most tools have their edges destroyed.

Through the means adopted, production in the plant was increased to such an extent that $17,000 was saved monthly in direct labor cost alone. This is equivalent to about $1.15 per machine per working day, and the tool cost was also reduced because of the saving in the tools and the less frequent grindings required.

In the next installment of this article, to be published in November MACHINERY, the maintenance problem will be dealt with. It is rather startling to learn that an auto-

mobile plant employing 7000 men spends from $400,000 to $500,000 a year merely on repairing and maintaining its machine tool and other production equipment in a serviceable condition. Among the subjects that will be dealt with are bearings and bearing troubles and maintenance of gearing. The value of heavy spindle construction will also be referred to. The methods of selecting machine tools in automotive plants will receive consideration, as well as the cooperation possible between salesmen and equipment engineers, the qualifications of salesmen and purchasing agents, the problem of production estimates, etc. In conclusion, the automotive engineer's view of the weakest spot in his own industry will be recorded. A following installment will give the machine tool builder's views on the problems dealt with.

* * *

Complete figures covering the automobile exports for 1923 have recently been published by the Department of Commerce. These indicate that 127,000 passenger cars were exported in 1923—approximately 3½ per cent of the total output. Australia took about one-fifth of the automobile exports, Canada coming second, with about one-ninth. The other leading customers of the United States, in the order of their importance, were Argentina, the United Kingdom, Spain, Mexico, Sweden, and British South Africa, each of which imported over $4,000,000 worth of automobiles. In the motor truck field, Japan was the leading buyer, followed by Australia, Canada, Belgium, United Kingdom, New Zealand, Mexico, and Sweden. The exports of motor trucks and motor buses amounted to about 10 per cent of the total output of the American motor truck industry.

HOPPER FEED FOR ROUND SHEET-METAL BLANKS

By S. C. HILLS

The hopper feed illustrated in this article is used for feeding round sheet-metal blanks to automatic machines in cases where more than one operation is necessary. The feed is provided with a drum *A*, Fig. 1, into which the blanks are poured. The vertical shaft *B* has a wedge-shaped finger *C* at its lower end. This finger can be replaced by one of any shape that may be designed to suit the blanks it is to

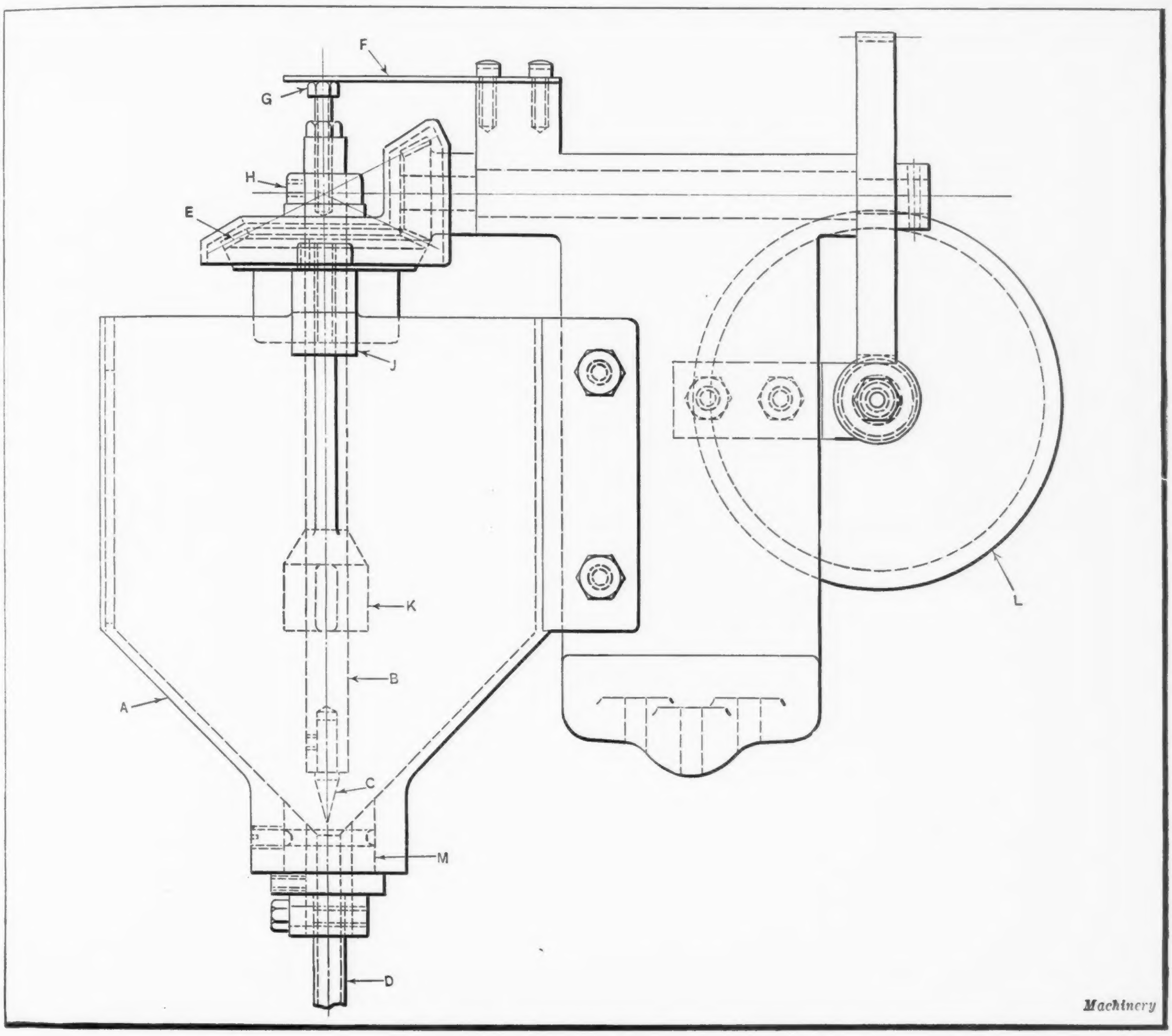

Fig. 1. Hopper Feed for Round Sheet-metal Blanks

enter or feed into the vertical tube *D* leading to the automatic machine.

The shaft *B* is driven by a gear *E* provided with a key that is a sliding fit in the keyway cut in the shaft. This construction allows the shaft to work up and down through the gear. The shaft is driven at a speed of about 50 revolutions per minute. The flat spring *F* is located directly above the shaft *B*. A screw *G*, which is threaded to fit the tapped hole in the upper end of shaft *B*, serves as a means of adjusting the downward pressure exerted on the vertical shaft by spring *F*. This provision is necessary, because the blanks sometimes collect under the finger *C* in such a way that the spindle is raised slightly against the tension of the spring.

Collar *H*, which is adjustable on shaft *B*, rests on the top of the bevel gear cover. The normal height of the finger *C* above the entrance to tube *D* is determined by the position of collar *H* on shaft *B*, and must be correct for the sizes of blanks being fed. The upper and lower bearings at *J* and *K*, respectively, which support the vertical shaft are

machined in cross-pieces cast integral with the hopper *A*. The belt-driven grooved pulley *L* drives shaft *B* through the intermediate spiral and bevel gears. The bottom of the hopper is bored out to receive the part *M*, which is shown in detail in Fig. 2. This part is bored out to fit the bushing *N* through which the blanks are fed to the tube *D*. The lower half of part *N* is cut away so that the clamping block *P* serves to clamp the bushing *N* and tube *D* in place. Part *N* is made of steel, and is bored out at the upper end to a diameter equal to the diameter of the blank to be fed plus 0.050 inch. Parts like that at *N*, with holes of different sizes, are provided for handling blanks of various diameters.

Two large slots, as shown at *R*, are cut in the feeding tube *D*, so that any blanks which enter the tube edgewise will be forced out through these openings and thus allow only the blanks that enter properly to continue down the tube to the point where they enter the automatic machine. The width of the slots *R* is made about 1/32 inch less than the diameter of the blanks to be fed through the tube. A piece of wire soldered to the back of the vertical tube serves to hold a cup under the openings *R* which catches the blanks that come down from these slots.

The lower end of tube *D* fits into the steel bushing shown at *S*. The hole at the lower end of this bushing is made about 0.025 inch larger than the blank. This bushing has an adjusting nut which provides a means of locating the lower end of the part the correct distance above the surface on which the blanks rest after leaving the end of the tube. From this point the blanks are carried into the machine by fingers that constitute a part of the automatic machine. A slot is cast in the side of the hopper and a piece of wire netting placed over this slot to retain the blanks and allow the operator to see how many blanks there are in the hopper. A feeding device of the kind described has been in use with very good results for six years in connection with

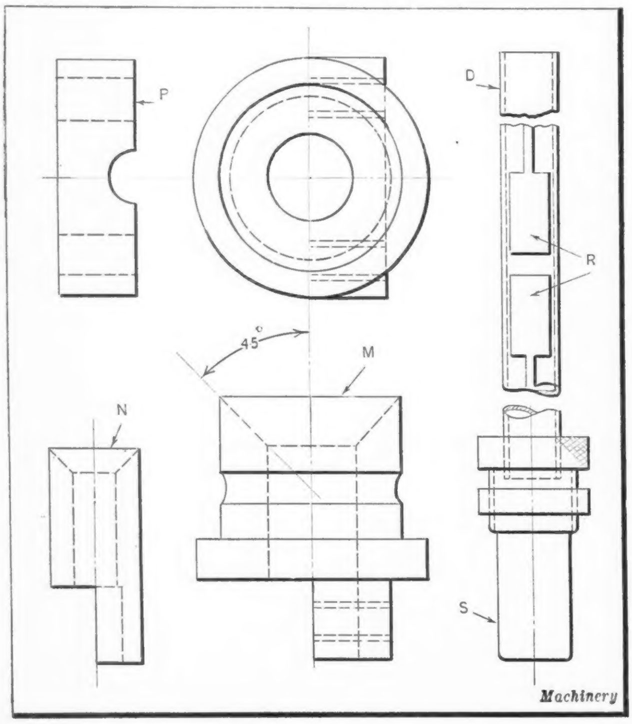

Fig. 2. Enlarged Views of Parts used in Feeding Device shown in Fig. 1

machines employed in the manufacture of upholstery nails, and similar products. The blanks handled by this machine range from 0.171 to about ¾ inch in diameter.

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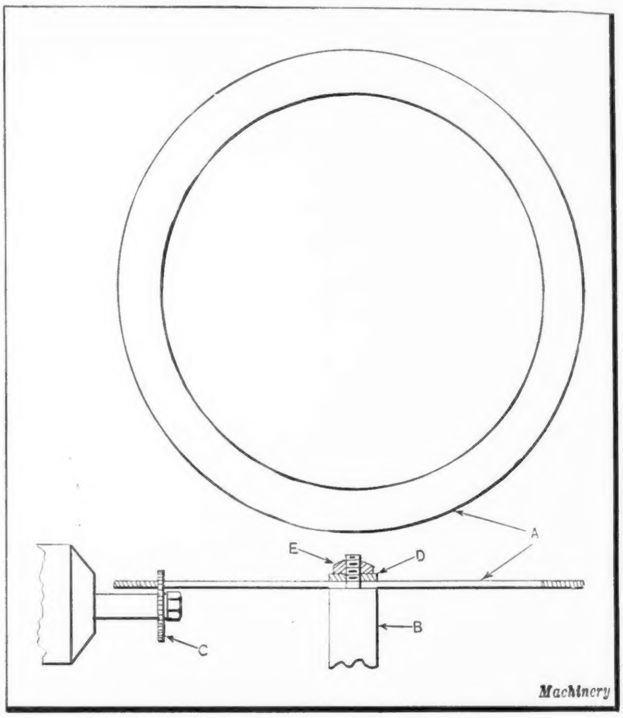
MACHINERY'S NEW PRIZE COMPETITION

An announcement of MACHINERY's new prize competition "The Most Interesting Device or Method for Gaging, Measuring, and Inspection that I have Ever Seen" will be found on page 101 of this number of MACHINERY.

MAKING A 36-INCH RING IN A 14-INCH LATHE

By LEWIS ROE

Twelve rings ranging from 30 to 36 inches in diameter and from 3 to 4 inches in width were required to be cut from soft sheet steel ⅛ inch thick. These rings, one of which is shown at *A* in the accompanying illustration, formed part of a spring wheel designed to replace the regular automobile tire. The only lathe available for cutting out the rings had a swing of only 14 inches, so that it was impossible to mount the sheet-steel blanks on the lathe face-



Method of cutting Ring from Sheet Steel

plate. However, this lathe was used by mounting the sheet steel in a horizontal position on a stud *B*, as shown.

The end of the special stud *B* was turned to a good running fit for the hole drilled and reamed in the center of each rectangular piece of sheet steel, and was attached to the lathe cross-slide in place of the regular toolpost. The pieces of sheet steel were held in place by means of a threaded collar *D* and a lock-nut *E*, the collar and lock-nut being adjusted to permit the plate to be revolved and yet not have any looseness or play. By bringing the work into the proper position with respect to the revolving cutter *C*, and then slowly revolving the work on stud *B*, it was possible to trim the outside of the ring to size. The inside of the ring was cut away in the same manner.

* * *

AN AMERICAN THERMAL UNIT

The following letter to the editor, published in the Boston *Herald*, must not be withheld from wider publicity:

"In the physics and science department of the Boston schools the young of this great nation are being taught that 778 foot-pounds of work are equivalent to one British thermal unit. This is obviously an attempt to spread British propaganda by means of the school curriculum and an attempt to alienate the younger generation from those fundamental principles of patriotism which should be cultivated in the breast of every future American voter.

"I, therefore, propose that the term 'British thermal unit' be changed to 'thermal unit of the United States of America' and, moreover, and in addition to this, that the value of said unit be changed to 1000 foot-pounds of work, thus making the American thermal unit the greatest thermal unit the world has ever known."

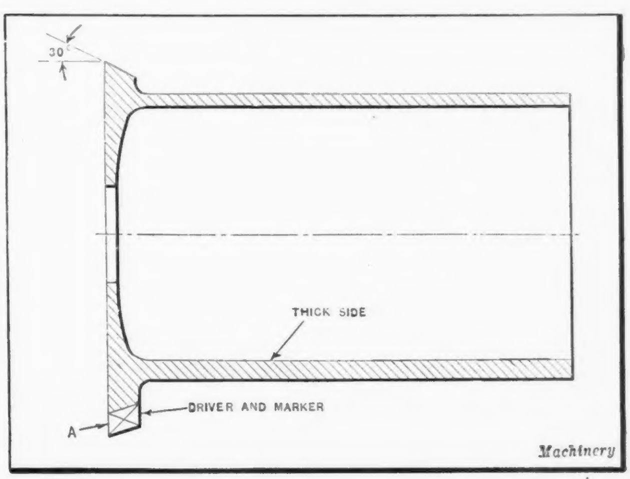
Piston-rings and their Production

By JAMES McINTOSH

IF it were possible to operate a gasoline engine in such a manner that the piston and the cylinder were kept at the same temperature and properly lubricated and if both the piston and cylinder would retain a true cylindrical form, there would be no necessity of using piston-rings. These desirable conditions cannot be obtained, however, and piston-rings are, therefore, essential to compensate for the change in fit of the piston in the cylinder. Low compression, crank-case oil dilution, and oil pumping are troublesome factors that result from defective or poorly fitted rings. Various types of piston-rings designed to prevent the troubles that generally result from poorly fitted rings have appeared on the market, but it has been the writer's experience that the plain type of ring is the most reliable and satisfactory when it is properly made.

Methods of Machining Piston-rings

It is of great importance that the castings from which the piston-rings are machined be of uniform quality. The most efficient methods of machining will not overcome defects caused by hard spots in the castings or produce a satisfactory ring if the casting does not have a sufficient amount of spring. The foundryman often makes the mistake of considering the piston-ring castings of minor importance as compared with the cylinder and the piston castings. As a matter of fact, there are no castings that should be given more careful attention than those from which the piston-rings are made.



Cylindrical or Pot Casting from which Piston-rings are cut

Two methods of producing piston-rings are employed. In one the rings are produced from individual castings, while in the other a number of rings are machined from a cylindrical casting. With the individually cast ring, most of the machine work can be done on a grinder. Rings made in this manner are generally the strongest, as the dense grain of the metal found close to the outside skin of the casting is incorporated in the ring. However, rings that are made from individual castings are more likely to have a poor fit than those that are machined from cylindrical castings.

Points on Casting

The metal in the piston-ring should be hard in order to resist wear, the degree of hardness being limited only by the amount of springiness the ring must have to permit it to be expanded sufficiently to pass over the piston before entering the grooves. Uniform hardness can be obtained when the castings are poured with metal tapped for the purpose in the middle of the casting period; the castings should never be poured from the surplus metal from what may seem to be a more important casting. The removal of the castings from the mold while red hot causes local cooling which produces hard spots. A piston-ring blank, if left in the mold over night, will cool off slowly so that it will be of uniform hardness or, in other words, it will be annealed under ideal conditions.

Finishing Piston-rings

Considerable care must be taken in finishing a piston-ring even when the casting is of uniform hardness. The cylindrical castings should be made with a minimum allowance for finish, and if the rings are eccentric, the metal patterns used to produce the molds should also be eccentric. An ideal pattern for a piston-ring casting is shown in the accompanying illustration. This casting has a beveled flange, and it is held for machining by a universal chuck, the jaws of which are turned to an angle of 30 degrees to fit the bevel on the flange. A block *A* is used to indicate the heavy side of the ring and to locate it at a marked position on the jaws. This block, which is part of the ring casting, also serves as a driver. With this method of holding the casting, there is no danger of the cylindrical part being sprung or distorted.

The first operation on the cylindrical or pot casting is generally that of turning the outside diameter eccentric with the inside, which is bored with a cylinder boring head adjusted to cut about 1/4 inch ahead of the tool which turns the outer surface. This m thod of machining tends to produce more accurate rings, as the rigid internal cutter serves to reduce vibration and distortion. A regulation gang cutter so arranged as to part or cut off the rings progressively is employed. The parting tools are located so that each one has a slight lead over the preceding one, and the rear edge of each tool also has a slight lead over the front edge, so that the rings will be cut off clean without leaving a fin or rough edge. The clearance side of the tool passes over the face of the succeeding ring, of course, before it is cut off by the next tool.

Testing the Piston-rings

The piston-rings may be subjected to a simple test after the first operation. This consists of cutting through one side of the ring with a hacksaw, and after measuring the opening or slot, slipping the ring over a slightly tapered mandrel to a step having a diameter equal to the outside diameter of the piston plus 1/16 inch. If there is any appreciable increase in the opening or width of the slot after this operation, it is safe to assume that a permanent set has developed, which would indicate that the ring lacks the required elasticity and is too soft. If the first ring taken from the casting fails to pass this test, it is taken as an indication that all the rings machined from that particular casting would not be satisfactory.

Facing the Sides

The second operation on the piston-rings is that of grinding the sides. Care should be taken to place the smoothest face of the ring in contact with the magnetic chuck when grinding the first side. If this precaution is not taken, there will be slight irregularities in the finished side of the ring. This irregularity is more pronounced in rings machined from individual castings. After both sides of the

rings have been finish-ground, the next operation is that of cutting the slot. If a plain diagonal slot is to be cut, it is best to use two slitting saws, properly spaced to remove the required amount of metal. The slots can be cut much quicker when two saws are employed, and the ring is subjected to less distortion. The fourth operation is that of grinding the outside diameter so that it will fit the cylinder bore.

Grinding the Outside Diameter

It is the usual practice to mount a number of rings on an arbor when grinding them to fit the cylinder bore. This grinding operation is performed after the sides of the rings have been finished and the slots cut. The rings are compressed and centered on the arbor before tightening the clamping nut by passing a sleeve over them. In some plants, attempts have been made to grind the rings with the slots closed, but when this is done the rings are likely to buckle so that they will have high spots after they have been ground and removed from the arbor. It is obvious that the length of the ring measured on the circumference, must be exactly right if the ring is to have a closed slot when located in the centering sleeve. If the circumference of the ring is too great, the ring will buckle, and if it is too small, the ends of the ring will not meet to form a closed slot.

If the rings are allowed to have a slot opening of 1/32 inch, when mounted on the arbor ready for grinding, they can be compressed and properly located by the centering sleeve without danger of buckling. The width of the slot and the amount of metal to be removed in finish-grinding must be taken into consideration in determining the diameter of the unslotted ring. It is poor practice to grind a piston-ring with a closed slot, but it is possible to produce a ring that has a closed slot when finished. This is done by grinding the ring with an open slot and regulating the diameter to which it is machined so that its circumference after being slotted and ground is exactly the same as that of the bore it is to fit. It is even possible to grind a ring with an open slot that has sufficient surplus length to permit the ends to be cut away at opposite sides so that they will form an overlapping joint.

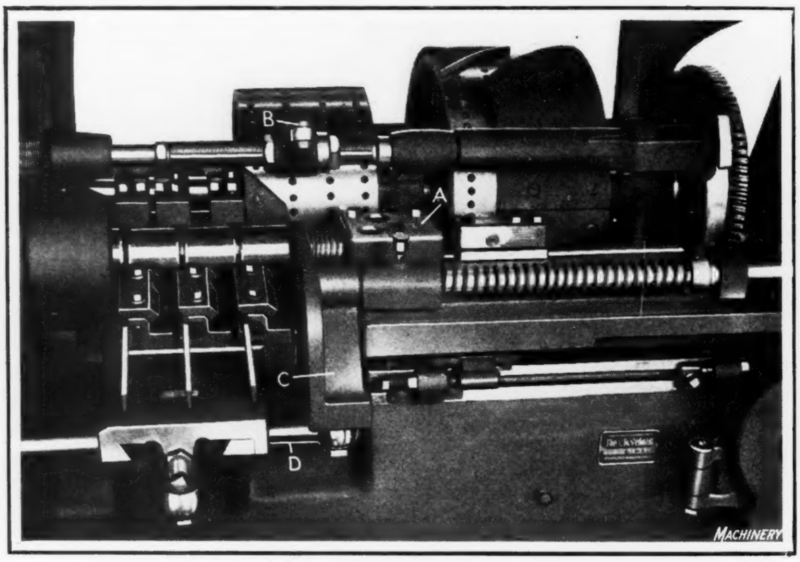
* * *

Were it not for labor-saving machinery, the shorter workday and the higher wages in industry that now prevail, as compared with fifty years ago, would be impossible. J. H. Barnes, president of the Chamber of Commerce of the United States, points out how machinery has made possible increased efficiency in industry. In the steel industry, for example, he mentions how in specific cases 1 or 2 men with unloaders replace from 12 to 20 men unloading by hand; in furnace charging, by the use of a skip-hoist, larry car, and an automatic weigher, 2 men replace 14; in pig casting, 7 men with a casting machine replace 60; in open-hearth operation, 1 operator with a charging machine replaces 40 hand chargers; in foundry work, with a traveling crane, 12 men pouring replace 37; 2 men unloading pig iron with an electric magnet and crane replace 128; and in unloading coal, an automatic conveyor with 12 men replaces 150.

CUTTING OFF PIPE COUPLINGS IN AN AUTOMATIC

In planning for simultaneously cutting off and rounding three couplings from pipe in an automatic machine, it was found desirable to use the arrangement here illustrated. The machine is equipped with a block *A* in which is mounted an arbor that is extended forward into the pipe to carry the couplings as they are produced. Flats are milled on the front side of the arbor to clear the tools on the front slide, as they cut through the stock. The machine used is a Cleveland automatic, and block *A* moves back and forth on the regular milling slide. The pipe is $2\frac{1}{8}$ inches inside diameter, and $2\frac{7}{8}$ inches outside diameter, and the couplings are $2\frac{5}{8}$ inches long. The production with this tooling equipment averages 300 couplings per hour.

At the beginning of a machine cycle, the stock is fed forward until it comes in contact with stop *B*, which is swung down into position for functioning. Then block or head *A* is advanced automatically to insert the arbor into the pipe, after which the front and rear tool-slides are fed simultaneously toward the center of the machine. The three tools on the rear slide round the corners of the couplings, and the tools on the front slide cut off the couplings. The tools on the front slide are so arranged that the right-hand coupling is cut off first, then the middle one, and finally the one adjacent to the headstock. When this step has been completed, head *A* and bracket *C* are moved as one unit toward the rear end of the machine, until the head has reached the maximum withdrawn position. When this position is reached, bracket *C* is moved forward again, due to the action of rod *D*, and in this movement the bracket pushes the couplings off the arbor and into a chute, which carries them from the machine. Rod *D* is operated by a mechanism at the head end of the machine.



Arbor and Ejector used in cutting off Pipe Couplings

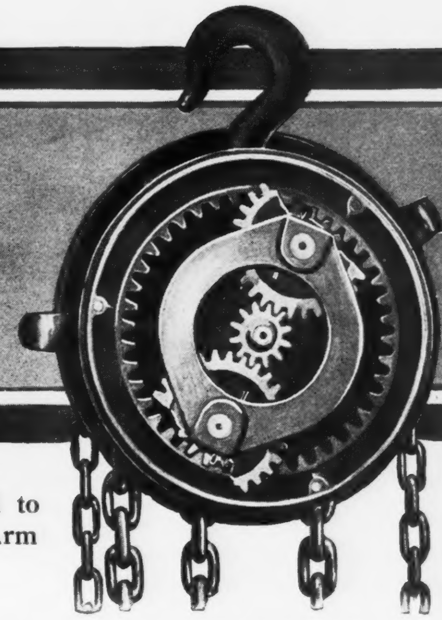
* * *

RELIABILITY OF AUTOMOBILE ENGINES

Some of the tests to which modern automobiles and automobile engines are subjected indicate the great advance in the reliability of these engines during the brief period that automobiles have been commercially built. The builder of one of the highest grade American cars recently brought out a new model, and in order to give this new car a thorough test before it was actually placed on the market, it was run over the regular roads of the country, almost continuously, for 100,000 miles, without any repairs or replacements being necessary, except minor adjustments. Even in the case of less expensive cars, very rigid tests are now being made. In one instance, the manufacturer of a car in the thousand-dollar class periodically submits an engine to a running test under load in the factory, equivalent to 20,000 miles; then the engine is taken apart, and inspected, minor adjustments are made, and it is again put on the test blocks and run continuously for eight days and eight hours, at fifty miles an hour under full load, this being equivalent to a continuous run of 10,000 miles at this high speed.

Planetary Gearing

By FRANKLIN DeRONDE FURMAN
Professor of Mechanism and Machine Design
at Stevens Institute of Technology



Combinations in which Arm for Planet Wheels is Keyed to Driving Shaft—Methods of Solution when Planet Wheel Arm is an Idler—Third Article

THE first article in this series, which was published in August MACHINERY, covered definitions, principles, grouping, methods of solution, and uses of planetary gearing, together with a definite problem solved in complete detail. The second article contained the solutions of five problems, each differing from the other in a characteristic way, but all falling in one group in which the train arm is keyed to the follower shaft. The present article illustrates problems in Groups 2 and 3. In Group 2 the train arm, which carries the planet wheels, is keyed to the driving shaft, and in Group 3 the train arm turns independently of both the driving and follower shafts. A further feature of this article is a consideration of the relative sizes of sun wheels and of planet wheels as affecting the ratio of reduction. The following notation is used:

N = number of turns of driver to one of follower or driven member;

N' = number of turns of follower to one of driver;

N_1 = number of turns of driver to one complete revolution of planet wheel axis;

N_2 = number of turns of follower to one complete revolution of planet wheel axis;

D = diameter of pitch circle of driver, if driver is a toothed wheel; (The driver, or the follower, may be the "train arm" and not one of the toothed wheels, according to the data given in a problem.)

D_1 = diameter of pitch circle of follower, if follower is a toothed wheel;

D_2 = diameter of pitch circle of fixed wheel; and

D_3, D_4, etc. = diameters of pitch circles of planetary wheels.

The Train Arm as the Driver—Problems 7 and 8, Group 2

In the preceding problems, the train arm which carries the pin for the planet wheels has been the follower, and N has been equal to N_1 in all cases, because the planet wheel pin was fastened in the train arm and both turned through 360 degrees in the same period of time. In this new group of problems, the follower will be one of the sun wheels, while the driver will be the train arm and will carry the planet wheel pin; consequently, the answer in each case will be the number of turns of the follower per one revolution of the planet wheel pin which is the same, in this new group of problems, as saying number of turns of follower to one of driver, because the planet wheel pin is fastened to the driver. In this group of problems, then, $N_2 = N'$. Since it is deemed advisable, in the early part of this work, at least, to give the answers to all problems in terms of N, it will become necessary in the present group of problems to find first N_2, or N', and then invert so as to obtain $N = \dfrac{1}{N_2} = \dfrac{1}{N'}$.

Problem 7—Given: $D_1 = 40$; $D_2 = 24$; $D_3 = 16$; and $D_4 = 32$ (see Fig. 9). Find N by the graphical and analytical methods.

The solutions of this problem according to the three methods described in the first article of the series, are identical in principle with the solutions given in previous problems, and the reader who has grasped the fundamentals should need no further explanation. For completeness, however, and in order to give any necessary aid in this first problem of the second group, two solutions are given.

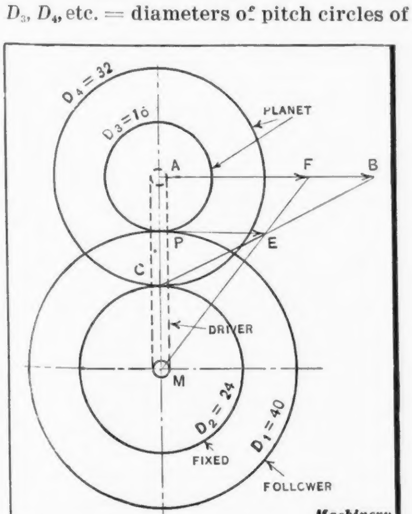


Fig. 9. External Planetary Gear Combination with Train Arm as Driver—Problem 7

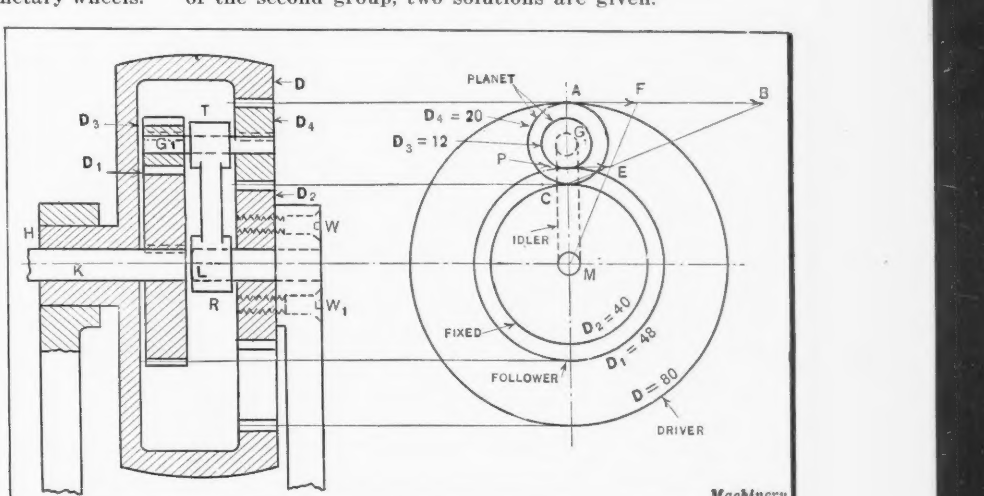


Fig. 10. Planetary Mechanism so designed that Train Arm of Planet Gears is not attached either to Driver or Follower—Problem 9

Graphical and Analytical Solutions of Problem 7

The graphical method of solution is shown in Fig. 9. It will be noted that the lettering in this figure has the same significance as the letters in previous figures; for example, the letter A is at the driving point and AB is the linear velocity of the driver at the point A. The letter C denotes the fulcrum or the point of effective contact between the teeth of one of the planet wheels and the fixed wheel. The line PE represents the linear velocity of a point on the follower, and is reduced or increased in each instance to get its corresponding value AF at the same radius as that at which the assumed driving velocity was taken. The letter M designates the axes of the sun wheels and of the driver and the follower shafts. According to the graphical method

$$N = \frac{AB}{AF}$$

By the analytical method, the formula is:

$$N' = 1 - \frac{D_2}{D_4} \times \frac{D_3}{D_1}$$

Substituting the values given in the data for the problem,

$$N' = 1 - \frac{24}{32} \times \frac{16}{40} = \frac{7}{10}. \quad N = \frac{1}{N'} = 1\ 3/7.$$

In other words, one and three-seventh turns of the driver shaft in one direction will produce one full turn of the follower shaft in the same direction.

Graphical and Analytical Solutions of Problem 8

Problem 8—Given: $D_1 = 64$ (internal); $D_2 = 48$ (internal); $D_3 = 28$; and $D_4 = 12$ (Fig. 11). Find N by the graphical and analytical methods.

Problem 8 differs from Problem 7 in that two internal gear wheels are used instead of all external wheels. Incidentally, the follower turns in an opposite direction, but this is not necessarily due to the use of the internal wheels.

By the graphical method,

$$N = \frac{AB}{-AF}$$

By the analytical method,

$$N' = 1 - \frac{48}{12} \times \frac{28}{64} = 1 - \frac{7}{4} = -\frac{3}{4} \text{ and}$$

$$N = \frac{1}{N'} = -1\ 1/3$$

Train Arm Not Attached to Either Driver or Follower Shafts—Problems in Group 3

It will be recalled that in the problems in Group 1 the train arm which carries the pin for the planet wheels was

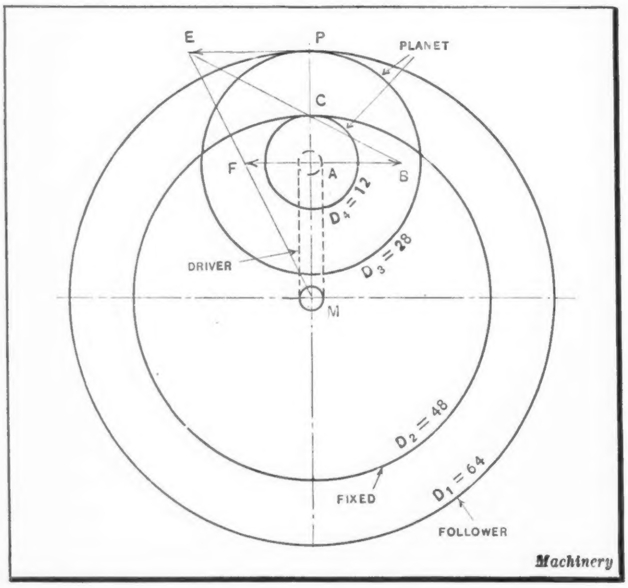


Fig. 11. Arrangement that provides Reversal of Motion, Internal Gears being used for the Fixed and Follower Members—Problem 8

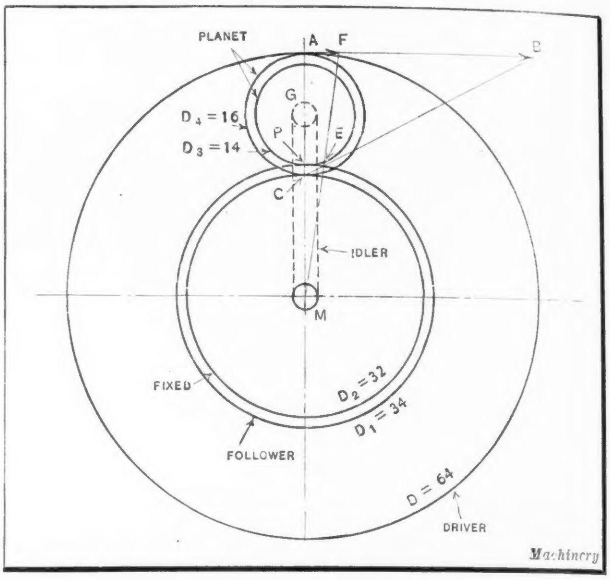


Fig. 12. Showing Effect on Graphical Method of Solution when Planet Wheels are nearly the Same Size—Problem 10

attached to the follower shaft; and that in the problems in Group 2 it was attached to the driver shaft. In the problems in the present group the train arm runs as an idler and is not keyed to the follower or driver shafts; hence in all problems that fall in Group 3, it is necessary to find first the amount the driving shaft rotates while the planet wheel axis revolves once, and also to find the amount the follower shaft rotates while the planet wheel axis revolves once. Then, dividing the number of turns of the driver by the number of turns of the follower, we have the number of turns that the driver makes during one revolution of the follower. This will be explained in detail in the next problem to be considered.

A form of mechanical construction for problems in Group 3 is shown in Fig. 10 (see sectional view). The driving wheel D is in the form of a pulley, with 80 internal gear teeth cut in one of the side walls of the pulley and with a hollow supported shaft H cast integral with the other side wall. The pulley, crowned as shown, is driven by a belt. The turning of the driving wheel causes the planet wheel D_4 to roll on the fixed sun wheel D_2. The gear wheel D_2 is kept stationary by the screws WW_1 in the framework of the machine. The planet wheel D_4 is keyed to the planet wheel pin G_1, and so is the planet wheel D_3. The planet wheel pin G_1 turns freely in the train arm TR whose function, in all Group 3 problems, is simply to support the pin. The train arm turns freely on the stud L which is fixed in the framework. The planet wheel D_3 has the same rolling and turning motion as the planet wheel D_4 and if both were the same size the follower wheel D_1 would be kept stationary the same as D_2. But since D_3 is smaller than D_4, D_3 imparts a turning motion to the follower gear wheel D_1 which is keyed to the follower shaft K.

Graphical Solution of Problem 9

Problem 9—Given: $D = 80$ (internal); $D_1 = 48$; $D_2 = 40$; $D_3 = 12$; and $D_4 = 20$ (see Fig. 10). Find N by the graphical, geometrical, and analytical methods.

The graphical solution for Problem 9 is shown at the right in Fig. 10, where AB is the assumed tangential velocity at the pitch circle of the driver. This is also the actual velocity of a point on the pitch circle of the planet wheel D_4 which is actually turning about the point C of the fixed gear wheel, as a fulcrum. Since the two planet wheels D_3 and D_4 must act as one solid piece, because they are both keyed to the pin G_1, the point P on the pitch circle of the planet wheel D_3 must have an actual tangential velocity PE about C. Since the planet wheel D_3 and the follower wheel D_1 are in pure rolling contact, PE must also represent the actual tangential velocity of the point P on the pitch circle of the follower wheel.

Inasmuch as the assumed linear velocity AB of the driver was taken at the radius MA, it is now necessary to find the value of the linear velocity AF of the follower at the same radius. This is done by drawing the radial line MEF. Now that the linear velocities AB and AF of the driver and follower are found, each at the same radial distance, they may be considered as measures of angular velocity, or more practically speaking, as measures of revolutions per minute of driver and follower shafts. The answer, then, by the graphical method is $N = \frac{AB}{AF}$.

Geometrical and Analytical Methods Applied to Problem 9

The solution of Problem 9 by the geometrical method, giving exact results, is based on the graphical construction as shown in Fig. 10. In the two similar triangles ACB and PCE, $\frac{AB}{PE} = \frac{AC}{PC}$, and in the two similar triangles PME and AMF, $\frac{PE}{AF} = \frac{PM}{AM}$. Combining these equations, $\frac{AB}{AF} = \frac{AC \times PM}{PC \times AM}$. Substituting the values from Problem 9, $AC = 20$, $PM = 24$, $PC = 4$, and $AM = 40$, we have

$$N = \frac{AB}{AF} = \frac{20 \times 24}{4 \times 40} = 3$$

Hence the driving pulley D makes three full turns while the follower shaft K makes one full turn in the same direction.

The analytical method for solving Problem 9, and all problems in Group 3, consists, first, in finding the number of turns of the driver while the planet wheel pin makes one revolution about M. This is found by the following equation, based on the same principles and reasoning as in previous problems:

$$N_1 = 1 + \frac{D_2}{D_4} \times \frac{D_4}{D} = 1 + \frac{40}{20} \times \frac{20}{80} = \frac{3}{2}$$

The second step consists in finding the number of turns of the follower wheel D_1 and shaft K while the planet wheel pin makes one revolution about M. This is found by the following equation:

$$N_2 = 1 - \frac{D_2}{D_4} \times \frac{D_3}{D_1} = 1 - \frac{40}{20} \times \frac{12}{48} = \frac{1}{2}$$

Finally, according to the notation, the number of turns of the driver per one of the follower is:

$$N = \frac{N_1}{N_2} = \frac{3}{2} \times \frac{2}{1} = 3$$

The nine problems preceding cover varying examples of all ordinary problems in planetary gearing where only spur toothed wheels of the same pitch are used. The data given in the problems thus far have been chosen so that the two planet wheels have been quite different in size, thus giving an open graphical construction to the drawings and making them easier for the beginner to read and study. But it may have been noted that most of the problems have had a small reduction of only two or three turns of the driver to one of the follower. A few examples will now be given in which the planet wheels are more nearly the same size, and it will be observed that the ratios of reduction will, in general, be considerably increased. In these new problems the graphical construction will not, in general, give sufficiently accurate results to be useful unless drawn with great precision on an enlarged scale on a large drawing board and with suitable equipment. As this is not practical in an ordinary reading or study of the subject, an approximate or freehand graphical construction should be made and used as a basis for the geometrical method of solving these problems. In giving the problems from now on, it will not be stated to which of the three fundamental groups the problem belongs, and it will be necessary to first decide whether the problem is to be solved directly for N, or indirectly by finding N' or $\frac{N_1}{N_2}$.

Geometrical and Analytical Solutions of Problem 10

Problem 10—Given: $D = 64$ (internal); $D_1 = 34$; $D_2 = 32$; $D_3 = 14$; and $D_4 = 16$ (see Fig. 12). Solve by the geometrical and analytical methods. This problem is taken from the planetary reduction gear used on the Fellows gear shaper.

If lines for the graphical solution of Problem 10 are drawn and measured with the ordinary care that would be given to academic problems, it is likely that the result of $N = \frac{AB}{AF}$ will differ from the true answer too much even to serve as a reliable guide in corroborating the result obtained by the analytical method. Therefore, the graphical construction in Fig. 12 may be used merely as a basis for the geometrical solution which is the same in principle as for Problem 9.

Substituting the given values,

$$N = \frac{16 \times 17}{1 \times 32} = 8\tfrac{1}{2}$$

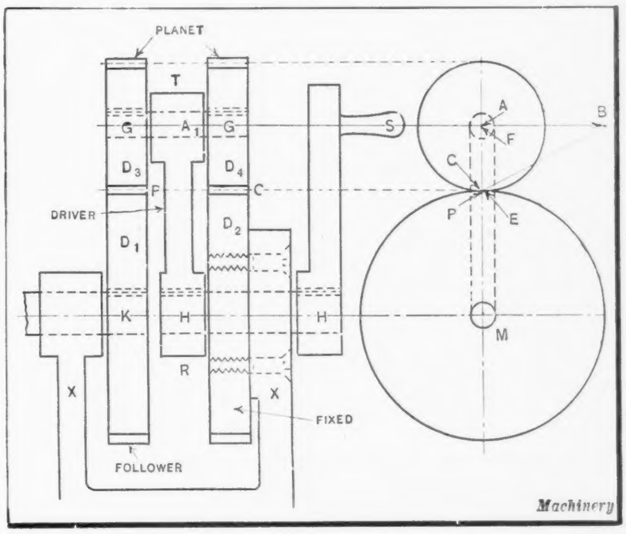


Fig. 13. Planetary Gearing so proportioned that Motion of Driver is not imparted to Follower, the Ratio of Reduction being Infinite—Problem 11

Using the analytical method for solving Problem 10, it is to be observed, first, that the planet wheel pin G is neither the driver nor the follower, according to the assigned data, and therefore this problem falls in Group 3 and is to be solved by finding N_1, then N_2, and finally, dividing N_1 by N_2 to find N, the procedure being the same as shown for Problem 9. Thus

$$N_1 = 1 + \frac{32}{16} \times \frac{16}{64} = \frac{3}{2}$$

$$N_2 = 1 - \frac{32}{16} \times \frac{14}{34} = \frac{3}{17}$$

and

$$N = \frac{N_1}{N_2} = \frac{3}{2} \times \frac{17}{3} = 8\tfrac{1}{2}$$

Arrangement which would not Transmit Motion to Follower

Problem 11—Given: $D_1 = 36$; $D_2 = 36$; $D_3 = 18$; and $D_4 = 18$ (Fig. 13). Solve by the graphical, geometrical, and analytical methods.

In Problem 10 the planet wheels approached more nearly to the same size than in the preceding problems, and in the present example, the planet wheels are the same size; also the sun wheels are of necessity the same size. In this case the reduction ratio is infinite; that is, it would take an infinite number of turns of the driver shaft H to make the follower shaft K turn once. In other words, the follower

shaft will stand still no matter how fast or how much the driver shaft is turned. Although Problem 11 is a special case, it may be solved by each of the three methods, the same as the other problems.

By the graphical method, AB, Fig. 13, represents the tangential linear velocity of the point A on the train arm driver. This is also the linear velocity of the point A at the center of the planet wheels. But the planet wheel D_4 is actually turning about the fixed pitch point C of the toothed wheel D_2, because wheel D_2 is fixed to the frame of the machine, as indicated by the screws in the side view. Since the two planet wheels D_4 and D_3 are keyed to the planet wheel pin G, the point P of the wheel D_3 is also fixed, or stationary for the instant. It follows from this that the point P of the follower wheel D_1 is also stationary. If P of D_1 is stationary, the entire wheel is stationary and the shaft K will not turn, even though the shaft H is turning.

Following up the graphical solution, if the point P of D_1 is stationary, it will have zero velocity, which is represented graphically by the points P and E falling together. If the point P on the wheel D_1 has a zero linear velocity at the radius PM, it will also have a zero velocity at the unit radius AM, and the line AF representing this velocity will be zero in length. If AB equals 5, then, according to the graphical method, $N = \frac{AB}{AF} = \frac{5}{0} =$ infinity.

The geometrical method for solving Problem 11 is also applicable in this special case if the analogy of the method is used. In this case, the theoretical triangle PCE, which is similar to ACB, is reduced to a point; and the two theoretical and similar triangles PME and AMF are reduced to a line. By analogy, however, the formulas $\frac{AB}{PE} = \frac{AC}{PC}$ and $\frac{PE}{AF} = \frac{PM}{AM}$ may be written. By substituting values given in the data, or derived from the data of the problem,

$$N = \frac{AB}{AF} = \frac{AC \times PM}{PC \times AM} = \frac{9 \times 18}{0 \times 27} = \text{infinity}$$

The analytical method for solving Problem 11 applies more satisfactorily, perhaps, to this special case than either of the other two methods. Noting that the train arm is the driver, it follows that the answer will come out in terms of number of revolutions of the follower per one of the driver which is N' according to the notation. Then,

$$N' = 1 - \frac{D_2}{D_4} \times \frac{D_3}{D_1}$$

$$= 1 - \frac{36}{18} \times \frac{18}{36} = 1 - 1 = 0, \text{ and}$$

$$N = \frac{1}{N'} = \frac{1}{0} = \text{infinity}$$

* * *

SCREW THREAD STANDARDS

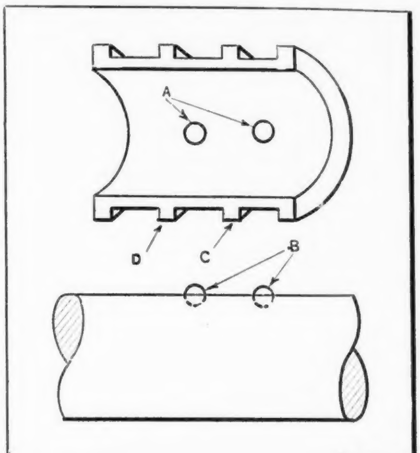
A pamphlet of thirty-two pages containing the standards adopted by the Committee on Standardization and Unification of Screw Threads has been published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City, the price being 50 cents to non-members of the society and 45 cents to members, with reductions for orders in quantity. The publication is known as "American Standard Screw Threads for Bolts, Machine Screws, Nuts and Commercially Tapped Holes." When the standards adopted in this report are generally accepted by the industry, the threads on this class of work will no longer be described as United States Standard, Society of Automotive Engineers Standard, or the American Society of Mechanical Engineers Standard; the terms "American (National) Standard Coarse Thread" and "American (National) Standard Fine Thread" will take their places.

PREVENTING SPLIT PULLEYS FROM SLIPPING ON SHAFT

By WILLIAM CUMPSTEY

Considerable trouble is experienced in some plants in keeping pressed-steel pulleys from becoming loose on their shafts. This trouble may be caused by excessive overloading of the power-transmitting equipment, but regardless of the cause, it can usually be remedied by the simple method described in this article. As many plants are not provided with a portable shaft splining machine, the usual method of dealing with a slipping pulley is to insert a new pair of bushings. The best method, however, is to spline the shaft and bushing and set in a key, but this requires considerable time, especially if it is necessary to take down the shaft so that the splining operation can be performed on a milling machine. Even if a portable splining machine is used, considerable time is lost.

An effective method of preventing the pulleys from slipping on their shafts, which can be quickly applied, is to drill two holes in the pulley bushing corresponding to two holes drilled in the shaft, and place steel balls in these holes before clamping the pulley to the shaft. The holes in the bushing, indicated at A in the accompanying illustration, should be drilled directly over the ribs C and D and should not be drilled to a depth greater than one-half the diameter of the steel ball. Steel balls about 11/16 inch in diameter should be used for shafts 2 15/16 inches in diameter, and balls about 9/16 inch in diameter for shafts 2 7/16 inches in diameter. Proportionally smaller balls should be used for smaller shafts. The drill used should be 1/64 inch larger than the diameter of the steel ball. The shaft should be carefully scribed so that the distance between the drilled holes will correspond exactly with the distance between the holes drilled in the bushing. The balls should be put in place on the shaft and the bushing set over them before the pulley is finally clamped in position, in order to make sure that the balls will not hold the bushing away from the shaft. An electric portable drill can be used to advantage in drilling the holes in the shaft and the bushing.



Method of using Steel Balls to prevent Pulley from slipping on Shaft

* * *

During the six months from January 1 to July 1, 1924, the railroads of the United States scrapped almost as many locomotives as were bought, so that on the latter date the number of locomotives was only 28 greater than the number on January 1; but the new locomotives installed during the period increased the tractive effort of the total number of locomotives in service by over 27,000,000 pounds, because the new locomotives installed during the six months had an average tractive effort two and one-half times as great as that of the locomotives retired. The average tractive effort of the new locomotives was 52,000 pounds, as compared with 22,500 pounds for the locomotives retired, which were of smaller and obsolete types. In total, on July 1, 1924, the railroads of the United States owned 64,924 locomotives with an average tractive effort of 39,500 pounds per locomotive. The number of freight cars owned on the same date was 2,314,798, with an average capacity of 43.9 tons per car.

Assembling Packard Cylinder Blocks to Crankcases

By CHARLES O. HERB

CONSIDERABLE care must be taken in assembling the cylinder block of an automobile to the crankcase unit in order to prevent breakage of the piston-rings, distortion of the pistons, and bending of the connecting-rods. Because of the care necessary when the various parts are guided into place by hand, the time required for the assembly of the two units is comparatively great. The time for this operation has been materially reduced at the plant of the Packard Motor Car Co., Detroit, Mich., by the use of a special equipment which holds the piston-rings compressed and the pistons in alignment so that the operation is accomplished without the undesirable effects mentioned.

The special equipment is located at a point on the regular crankcase assembly line, along which the crankcase is pushed on two round bars, being supported by four grooved pulleys as shown in Fig. 1. The cylinder block *A* to be assembled is attached to a head *B* by means of large thumbnuts which are tightened on studs projecting from the top of the cylinder block. At the rear of the assembly line there is a machine having two horizontal rods that support a casting on the forward ends to which are attached three parts *C*. Each of parts *C* closely fits two pistons on the rear side. When a crankcase has been located opposite this machine, handle *D* is operated to admit air into the machine so as to force parts *C* forward into contact with the pistons.

The half clamps *E* are then placed on the front of the pistons, the clamps being locked automatically to parts *C*. The assembly of these clamps compresses the piston-rings solidly in the pistons and holds the pistons perpendicular for the operation. Supported in two brackets which extend toward the front of the machine, are two vertical posts *F* which enter bearings in head *B* when the latter is lowered, to locate the cylinder block and guide it into place over the pistons. After the clamps *E* have been applied, head *B* is lowered by gravity over posts *F*. As the cylinder block comes in contact with either of units *C* and *E*, the latter

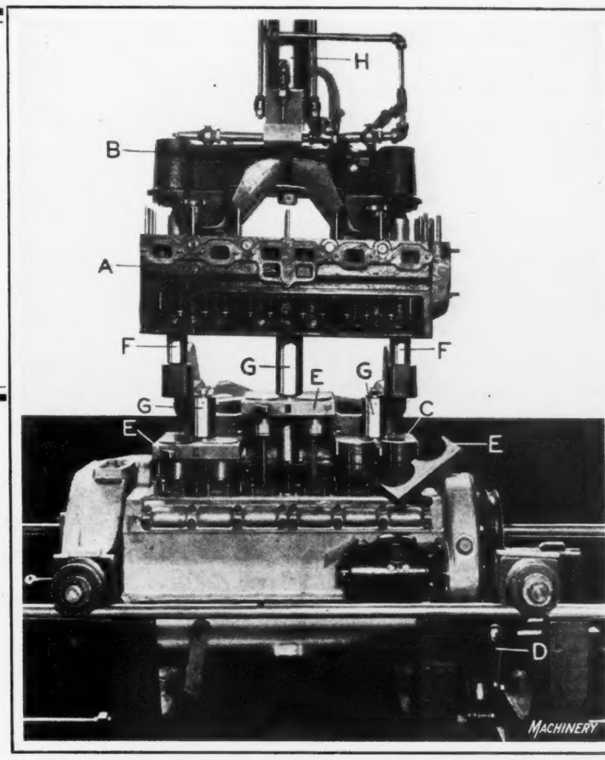


Fig. 1. Special Pneumatic Equipment employed for assembling the Cylinder Block of Packard Automobile Motors to the Crankcase

are lowered, posts *G* being depressed as the cylinder block comes in contact with an adjustable screw on top of the posts. Parts *C* are mounted on these posts. As parts *C* have a vertical movement, they may be utilized to compress the piston-rings until all the rings have been entered into the cylinder block. The adjusting screw on each post *G* permits of accurately controlling the moment of starting to lower the clamp controlled by any particular post.

When the cylinder block has been lowered over the piston-rings, the front clamps *E* are quickly removed by simply depressing a trigger on each clamp, and when the last clamp has been taken off, the machine at the rear automatically returns the fixture to which the rear halves *C* are attached. Fig. 2 shows the relation between the crankcase and the cylinder block at the time clamps *E* are unlocked, two of the clamps having been removed when the photograph was taken. Fig. 3 shows the cylinder block resting on the crankcase at the end of the operation.

When the assembly has been completed and the cylinder block released from head *B*, Fig. 1, the head is lifted rapidly from the work by simply depressing a valve button on the

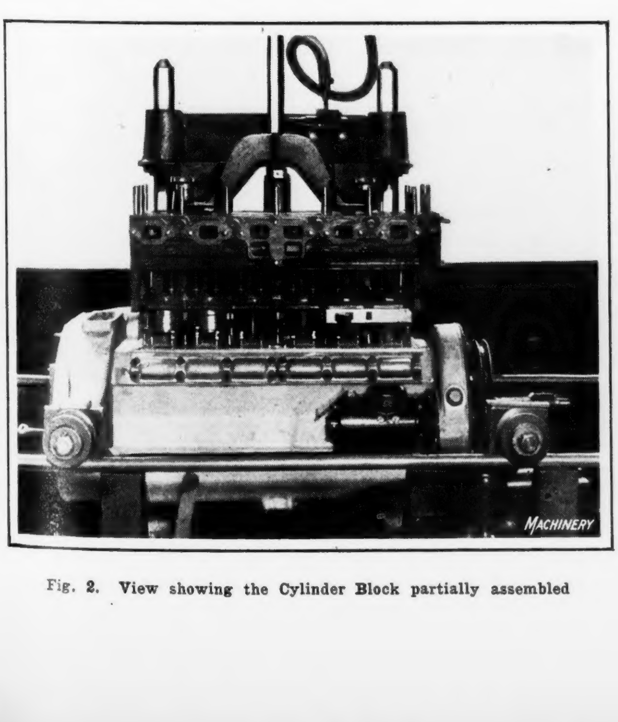


Fig. 2. View showing the Cylinder Block partially assembled

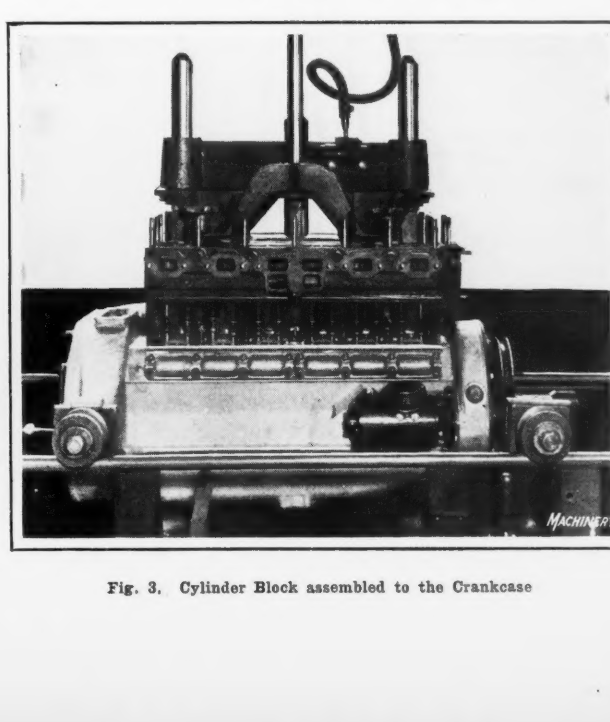


Fig. 3. Cylinder Block assembled to the Crankcase

pipe line of head *B*, which allows air to enter cylinder *H*. Head *B*, complete with its pneumatic equipment, is mounted on a trolley that runs on an overhead track at right angles to the crankcase assembling line. Thus the equipment can be quickly pulled to one side for reloading without interfering with the movement of the assembled motor unit along the assembly line and the advance of another crankcase into position for assembling to the cylinder block. The illustrations show the equipment used in connection with a six-cylinder block. A somewhat similar equipment is used for assembling eight-cylinder motors.

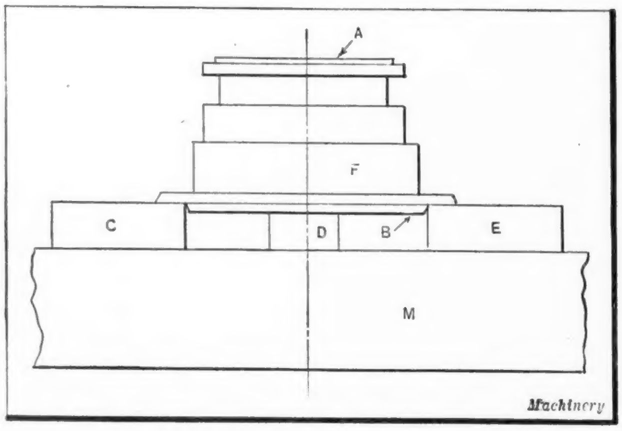


Fig. 1. Method of holding Forming Tool on Magnetic Chuck

* * *

FINISHING CIRCULAR FORMING TOOLS

By B. F. EDDIE

In a certain plant where the writer was employed, all the tools, when received from the hardening room, were ten-thousandths inch over size. This allowance was necessary because the only furnace available for hardening required the work to be subjected directly to the blast in order to obtain the required temperature. In consequence, the work was slightly pitted and had a scaly surface. Thus in making forming tools like the one shown at *A*, Fig. 1, it was necessary to remove about 0.005 inch from all the cutting surfaces by grinding after hardening.

The forming cutter *A* is shown in Fig. 1 set up on the magnetic chuck of a surface grinder for the first grinding operation. In this case the tool rests on three parallel blocks *C*, *D*, and *E*, which are equally spaced around the cutter. The wheel used to grind the upper face of the cutter was dressed down so that it had a cutting edge 1/8 inch wide. A fine feed and light cuts were used to grind the face so that the position of the work on the magnetic chuck would not be changed.

After grinding one end or face of the forming tool as described, the work was turned over and the finished side placed directly in contact with the magnetic chuck. The work was then in position for grinding the other side. When both sides of the work had been ground, the cutter was placed on the mandrel shown at *G*, Fig. 2, the nut *H* being tightened just enough to hold the work in place while truing it up between the centers of a bench lathe by the use of an indicator. After the work was trued up in this manner and the nut *H* tightened, the indicator was again employed to check the setting. The regular bench lathe grinder shown in the lower view of Fig. 2 was mounted on the cross-slide of the bench lathe at an angle of 15 degrees for grinding the unfinished surfaces of the cutter. While grinding wheels of various grades and grain could be used for finishing the cutter, a Norton 2- by 1/8- by 1/4-inch bore, grain 80, grade K, No. 38 abrasive wheel was employed in this case for rough-grinding the cutter, with satisfactory results.

After rough-grinding the cutter all over, leaving about 0.003 inch for finishing, a 2- by 1/8- by 1/4-inch bore, grain 100, elastic, grade 3 wheel was used for finishing the cutter all over. The corners of the forming cutter, however, were finished with a 2- by 1/8- by 1/4-inch bore, grade N, Norton miter wheel, such as is used for glass cutting. After the diameters and shoulder lengths of the tool were checked, it was removed from the mandrel and clamped in a vise on the tool grinder, where it was gashed to form the cutting edge.

The finished forming tool was mounted on a holder such as shown in Fig. 3. A trial piece of work was formed by the cutter, and when it was found that it did not check up accurately, the tool was again mounted on the mandrel and the required corrections made by grinding with the finish-grinding wheel. When a trial piece was found to be correct, it was filed away for future reference. The grinding operations on tools of the type shown were performed in about 4 1/2 hours. Forming tools made from "Blue Chip" high-speed steel in the manner described have proved very accurate and durable.

* * *

Iceland, although small as a market for automobiles and motorcycles, is to be closed to this trade for two years by an official decree just passed by the Icelandic Parliament.

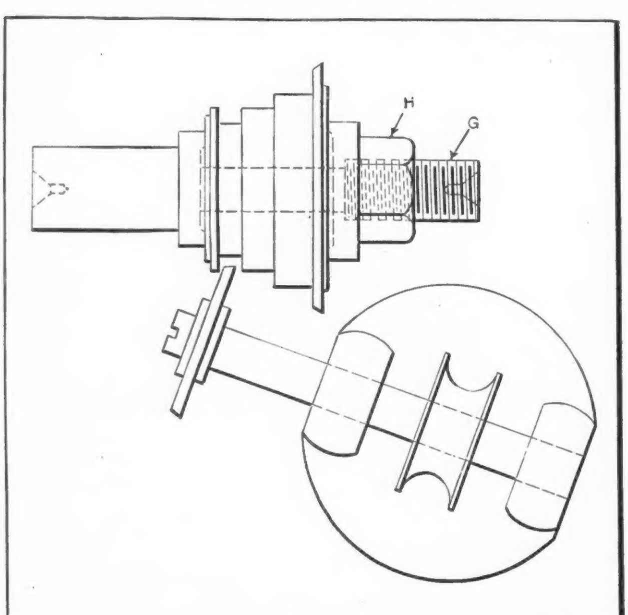


Fig. 2. Relative Positions of Work and Grinding Wheel

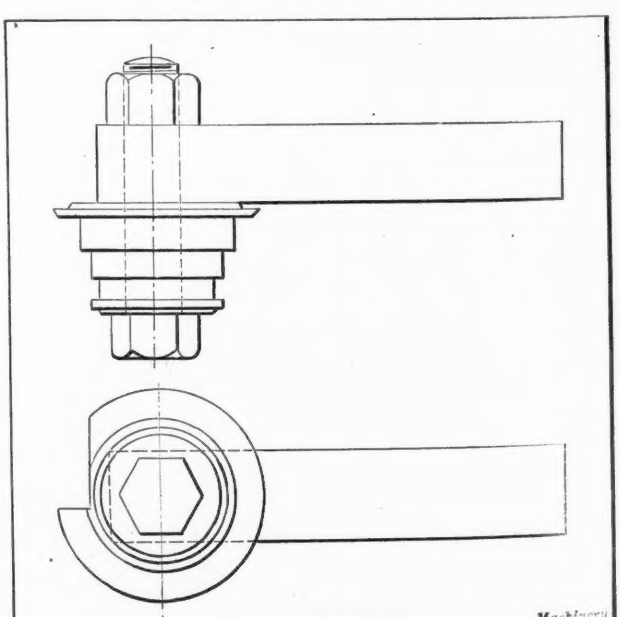


Fig. 3. Forming Tool mounted on Holder

BRITISH METAL-WORKING INDUSTRIES

From MACHINERY'S Special Correspondent

London, September 12

The conditions in the metal-working industries during August showed little change. Business, though giving no cause for pessimism, was generally quiet. The chief interest in the industry during the present month centers on the Machine Tool and Engineering Exhibition at Olympia. As machine tools at the British Empire Exhibition are very few in number, Olympia this month may be called the complement of the larger exhibition at Wembley. It is thoroughly representative of the latest British machine tool practice, and offers an opportunity of examining all the important developments that have taken place during the last four years. The present exhibition is distinguished from that held in 1920 by the fact that business is now on a rising curve, although the level is low, while in 1920 business was falling rapidly from a high level.

For machine tools, the demand as a whole is better, the evidence being that users are at last beginning to feel the need of more modern equipment, and machine tool makers should soon feel the benefit. It has long been patent that much of the existing equipment in many manufacturing establishments is totally inadequate to face modern competition, although not until quite recently have replacements been made on anything but the most meager scale. However, this attitude is changing, and very little more is required to restore the machine tool industry to a normal condition. Meanwhile, business in turret lathes continues to be brisk. In other directions, works engaged on special machines for the railway car industry have as much work as they can handle without increasing the present facilities.

There are cases where works are still operating at reduced strength, but quoting long-date delivery against new inquiries, often as much as nine months. Stronger demands are being made on small tool manufacturers, and on firms who specialize in the supply of jigs, fixtures, and tooling equipment generally. Makers of some of the larger and more expensive automobiles are placing orders for this class of work, and there is a good deal of activity in connection with tooling equipment for Diesel engine production.

Overseas Trade in Machine Tools

In July, for the fourth month in succession, the export of machine tools showed an increase, 1427 tons with a value of £146,950 being shipped, which represents an increase of 50 per cent over the monthly average for the first six months of the year. For July the value per ton of exported machine tools was £103, as compared with £109 for the monthly average up to June.

Imports of machine tools in July also showed a substantial increase, the figures being 393 tons with a value of £59,960, as compared with a previous monthly average of 271 tons with a value of £44,450. The value per ton of imports was £153, the average value up to June being £164.

General Engineering Field

The last month has not been very satisfactory in many of the large sections of the engineering field. Railway rolling stock builders continue to receive fairly good orders for home and colonial railways, and locomotives are occasionally to be noted among recent orders. In the case of the latter, however, the number is insufficient to keep the several well equipped locomotive works in the country busy, although, on the other hand, we are apparently getting a fair share of the locomotive requirements in all parts of the world. In modern practice, six-cylinder locomotives are practically unknown, but the Garratt engine at present under construction for the London and North Eastern Railway will be of this type. Each group of eight-coupled wheels will be driven by three cylinders, and steam will be supplied to them by a very large boiler having a diameter of 7 feet and possessing an aggregate heating surface, with superheater, of a little over 3600 square feet, and a grate area of 5.63 square feet. This locomotive is designed to exert a maximum tractive effort of nearly 73,000 pounds, and it will weigh, in working order, 174 tons.

The present season is always the slackest for the automobile industry, but this year the falling off is not so pronounced as usual. The export trade is fairly well maintained, and in a few weeks next season's programs will be started. At the time of writing, the removal of the import duties has had no appreciable effect on British automobile sales, but the situation is being watched with interest. No mystery has been made as to the policy foreign manufacturers intended to adopt when the repeal of the duties was an accomplished fact, but up to the present nothing startling has occurred. Some price reductions have been made, although these, on an average, do not work out at more than 10 per cent. The biggest reductions in price have been made by Continental rather than American manufacturers, and it is from the former source that the most strenuous competition is feared. Against this must be put the notification of one of the largest British small car makers of a price reduction amounting to about 12 per cent.

PRIZE COMPETITION

MACHINERY offers fifteen prizes for the best articles submitted on

The Most Interesting Device or Method for Gaging, Measuring, or Inspection that I Have Ever Seen

Competing articles may describe any measuring or gaging device that is not on the market as a commercial product; the description may deal either with the measuring device itself, with the method of using it, or both. The article may also deal with an unusual method of using a standard commercial measuring device, but in that case the method, and not the device, must be the feature of the competing article. The object of this prize competition is to secure for publication in MACHINERY examples of advanced gaging, measuring, and inspection devices and methods.

For the best articles on this subject MACHINERY will award fifteen prizes:

Two prizes each will consist of MACHINERY'S Encyclopedia.

Two prizes each—ten volumes of MACHINERY'S Mechanical Library.

Four prizes each—five volumes of MACHINERY'S Mechanical Library.

Seven prizes each—three volumes of MACHINERY'S Mechanical Library.

The winner may select from the twenty-eight volumes of the library the titles he prefers. Should a winner of MACHINERY'S Encyclopedia already own this work, he may select, instead, any fifteen volumes from the Mechanical Library. In addition to the prizes awarded, regular space rates will be paid for the prize-winning articles when published in MACHINERY.

All manuscripts for this competition must be in the hands of the Editor of MACHINERY, 148 Lafayette St., New York City, on or before December 1, 1924. Articles that are not awarded a prize may, nevertheless, be accepted for publication, in which case they will be paid for at regular space rates. Manuscripts that are not published will be returned.

Current Editorial Comment

in the Machine-building and Kindred Industries

THE PRODUCTION MACHINE TOOL

Until about fifteen years ago the developments in American machine tools consisted largely of improvements upon the primitive standard machines in earlier use. These earlier types had been developed for the purpose of serving shops where a variety of work had to be machined; where the machines might be used on one kind of work one day and on another kind the next day. The machines then built were exceptionally well suited to the needs of those days, to use in railroad shops, engine-building plants, textile machinery shops, and in repair and jobbing shops of all kinds. The growth and development of the bicycle, sewing machine and small arms industries did not appreciably affect the design of general types of machine tools, because most of the parts made were small in size, readily produced by automatic screw machines with special attachments, turret lathes and other standard machines with suitable tooling.

With the advent of the automobile industry a new problem arose. The machining of comparatively large parts in great quantities was required, and the standard machine tools then made could not perform this work with the same speed as machines specially built for high-quantity production. Also, the standard machines, being more universal in their application, had many features that were useful only when applied to a variety of work. A demand therefore arose for what has been termed "production machines," which have many features of the standard machines, but which are provided with fewer speeds and feeds, fewer adjustments, fewer operating levers and handles, and, generally speaking, are much simpler in construction and easier to operate by unskilled labor.

These machines are not what are generally termed "single-purpose machines." By changing the tooling equipment they can be adapted to a variety of work, the same as standard machine tools, although their range is not so wide, nor can the changes for other work be made quite so rapidly; but these points are of less importance, because changes are not often required. These production machines, having fewer parts and less complicated mechanisms than the standard machine tools, can be built more cheaply, and as there are already a large number on the market, they probably soon will be considered standard machines, as are the older types; but will be termed "standard production machines" to differentiate them from the others.

The next few years will doubtless see a marked development in machines of the production type. As the machine tool equipment in the automotive industry is gradually becoming obsolete, much of it will be replaced by machines of this newer type, rather than by the improved types of the older line of standard tools. But the latter type will continue to be in demand for plants where production is not on a quantity basis, because in such shops the production machine tool would be of little use.

* * *

STEEL FOR SMALL TOOLS

When we consider the importance of small cutting tools in the machine shop industry—taps, dies, drills, reamers, milling cutters, counterbores, and similar tools—it is surprising how little definite information exists on the kind of steel most suitable for such tools. Different manufacturers have decided on different grades of steel for their product, but no comprehensive tests, the results of which are generally available to engineers, have been made to determine which grade of steel is actually the best for tools of this class. We do not mean that any actual brand of steel should be specified, but that certain properties should be defined that should be present in the kind of steel that is best for certain types of small tools. Carefully conducted tests—not so elaborate, perhaps, as Taylor's experiments on high-speed steel, but using his methods as a basis—would be of great value to the industries in determining what properties should be present in a steel best to qualify it for taps, drills, reamers, or cutters.

This important investigation offers an opportunity to some of the testing laboratories of our larger engineering colleges that are frequently looking for practical and useful subjects.

* * *

THE PROBLEM OF NOISY GEARING

Since the production of satisfactory engines for automobiles, probably no mechanical difficulty has troubled engineers in the automotive field more than that of producing noiseless gearing. The elimination of noise in gearing has proved difficult, for the simple reason that no one has discovered what causes noise when two gears engage with each other.

Many engineers continue the study of this problem, methods for grinding gear teeth have been developed to mitigate the noise in operation and the machines for cutting gears have been more and more perfected to insure accuracy; and while the enigma has not yet been solved, each contribution toward its solution is of great importance to the industry.

In the article, "Noisy Timing Gears—Causes and Remedies," in this number of MACHINERY, the author describes the means adopted to reduce the noise in timing gears and gives the results obtained in two well-known automobile plants. The success so far attained indicates that for practical purposes the problem may be solved by a careful analysis of all the conditions that determine the shape of gear teeth, the conditions of engagement between the teeth, and the methods by which the gears are manufactured and heat-treated.

* * *

LARGER KEYWAYS IN MILLING CUTTERS

The keyways in milling cutters are generally too small for the heavy duty imposed upon those tools, the present keyway sizes having been adopted years ago when milling cutters were not required to take heavy cuts with the rapid feeds now employed. An effort is being made to standardize the keyways for milling cutters, and we suggest that the committee having this in hand consider discarding the old so-called standards for milling cutter keyways and adopting an entirely new one. It might be better to employ two opposing keys than a single one, in which case the keys and keyways could be smaller; but if that is done, it should be clearly specified that two keys instead of one are to be used.

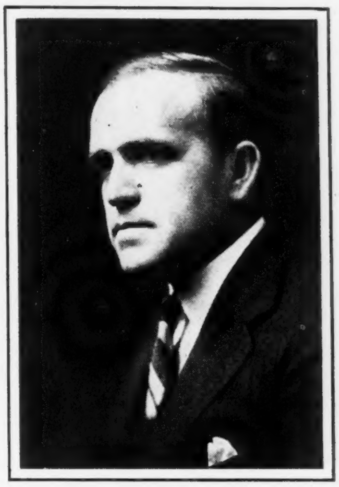
Some of the leading milling cutter manufacturers recently have been using larger keys and keyways than are employed in general practice, claiming that better results are thereby obtained, and their experience should guide the committee in its work. It is not necessary that the keys and keyways for ordinary shafting and pulleys be made uniform with those of milling cutters and milling cutter arbors. If it is found that the ordinary key and keyway sizes employed for shafting are entirely satisfactory for transmission purposes, but that larger keys and keyways are advantageous for cutters, there is no reason why a different standard for each should not be adopted. The subject is one worthy of careful study before definite standards are agreed upon.

Machine Tools for Automotive Shops

By LOUIS RUTHENBURG, General Manager, Yellow Sleeve-Valve Engine Works, Inc., East Moline, Ill.

THE automotive industry, when viewed from the administrative and economic side rather than from the technical side, has had too many generalities and too little specific analysis applied to its machine tool equipment. I believe that one of the most serious problems that the automotive and machine tool industries have in common is the one of establishing a sound economic balance between, on the one hand, extension of capital charges and accompanying costs growing out of the installation of improved tooling, and, on the other, the reduction of direct costs due to such installations.

Technically, a wonderful record has been established in providing tooling equipment for the automotive industry. Direct labor costs have been reduced to figures that a few years ago would have seemed impossible, but recent developments indicate that we have not given enough thought to the fact that such practice is profitable only as long as we can keep our plant load high.


Louis Ruthenburg

Many of the most elaborate installations of specialized machine tools have, of course, justified their installation. Where production quantities are high, approximately full plant loads are maintained, and models are not subject to frequent or radical change, large capital extension costs are quickly recovered out of savings in direct cost. But we must take into account the producer of smaller quantities, the quantity producer whose plant load fluctuates greatly, and the parts and accessory manufacturer; and also the cautious approach which should govern machine tool investments in new automotive enterprises. In such instances, machine tool investments should be governed by considerations of probable actual quantity, average annual load factor, and actual probability of design change, as well as by the consideration of direct labor saving. Generalities are dangerous. Each case ought to be subjected to the closest possible specific analysis.

In many instances when a recession in business is encountered, we find profit margins wiped out by a very slight reduction in plant load, and the profits of months of capacity operation offset by a comparatively short "idle-plant" period.

Possible Methods of Increasing the Plant Load

Under such conditions several superficial remedies suggest themselves. First, selling prices may be increased; but under adverse market conditions this may lead into the vicious circle of further reduction in volume, further increase of indirect cost per unit, further increase in selling price and so on, until a situation is brought about in which plant values must be written off and a fresh start made with a new financial set-up.

It may appear that sales can be stimulated by the introduction of a new model. But this introduces the contingent cost phase in which serious losses must be taken by the necessity for discarding highly specialized machine tools, along with fixtures, jigs and patterns—and there is always the chance that the market will not accept the new model with the expected enthusiasm.

Again, Ford's strategy may be attempted. By reducing the price of the existing model below the point justified by present cost, but based upon an expectation of increased volume and consequently reduced cost, sales may be stimulated and the plant load sustained without incurring the contingent penalties involved in the first and second courses. To some extent many automobile manufacturers have been pursuing such a course, and this may have had something to do with developing the present general situation. But automobile manufacturers other than Ford have competitors who can and do follow the same course, and the automobile-buying public will probably not absorb all the production capacity in a given price-class at any price that will insure profits to all of the manufacturers in that class. It is not apparent that Ford has either real or highly potential competition among other automobile manufacturers.

Why Machine Tool Equipment Requires Careful Selection

It may seem a far cry from the automotive problems that I have tried to outline, to the machine tool industry; but in all probability highly competitive conditions and a consequent desire for minimum cost, coupled with a tendency to follow Ford practices, has led to a situation in which many automotive operations are over-tooled in view of probable future average production.

I know an engine plant, for example, in which very elaborate lines of highly special machine tools were installed for the low labor-cost production of a certain passenger car engine in large quantities. It happened that this model had no logical place in the car market. When this was realized after months of disappointing volume and consequent high production costs, much of the equipment had to be scrapped to make way for a new model. Projected costs based upon the anticipated production were probably very low indeed; but the actual production volume led to prohibitive actual costs.

About the same time a wonderful axle plant was laid out. If the projected quantity could have been realized, costs would have been very low indeed. It so happened, however, that the maximum actual volume never approached the projected volume, and while the direct labor cost may have been the lowest ever attained for a similar axle, the capital charges per unit were so high as to make the total cost per unit prohibitive.

Requirements in Machine Tools for Automotive Plants

If it may be assumed that the analysis above is correct, it would seem that the need in the automotive industry is for machine tools that combine the following characteristics:

1. Relatively low first cost.
2. Adaptability to a fairly wide range of work.
3. Not too much capacity in a single machine tool unit.
4. Low cost of maintenance and fairly rapid set-up.
5. Approaching in as great a degree as possible the low direct labor cost possibilities of highly specialized, high-capacity-per-unit, inflexible, high-cost equipment.

It is understood that one cannot expect to have the very greatest labor-saving possibilities combined with the first four characteristics, but it is likely that lower average costs will result in many cases, even with labor cost somewhat increased, because of savings in capital and contingent costs.

Since 1920 there has undoubtedly been more caution shown in the industry toward elaborate and highly specialized machine tool installations. Present conditions will probably serve to emphasize this tendency.

COAL STORAGE UNDER WATER

According to investigations carried out by the Bureau of Mines, the expense of under-water storage equipment is not justified except as a preventive of fires from spontaneous combustion. In fact, the amount of deterioration of coal during storage has been commonly overestimated. While underwater storage of coal prevents deterioration of calorific value, in five years' storage in the open air Pittsburg coal deteriorated only about 1 per cent in one year, 2 per cent in two years, and from 2.5 to 3 per cent in five years. Pocahontas coal—a semi-bituminous type—lost less than 1 per cent of its heating value during two years of outdoor exposure. The Sheridan, Wyoming, sub-bituminous coal, known as "black lignite," lost 3 to 5.5 per cent of its heat value in two and three-fourths years of outdoor storage, the greater part of this loss being in the first nine months. The lumps became badly cracked so that they broke up on handling. By the use of bins with air-tight bottoms and sides and a protecting layer of fine slack, the loss in heat value in one year can be kept below 3 per cent and the physical deterioration will thus be largely prevented.

NATURAL CEMENT

Natural cement is made by burning mixtures of clay and carbonate of lime, or by calcination of a silicious limestone containing magnesia, and may be considered as Portland cement of inferior quality. This cement is a good building material for ordinary purposes, but is not as suitable for heavy and important concrete constructions as Portland cement.

STAGGER-FEED PRESS

A punch press equipped with a stagger feed is so arranged that the punch cuts blanks in a staggered relation to one another, thus reducing waste and utilizing the stock to the greatest extent. Such a feed is especially suitable for the production of such parts as can tops and bottoms and other small shells. The sheet stock is held in a carrier which travels past the reciprocating punch. The stagger feed may be so designed that it is not necessary for the carrier to be returned to the starting point after punching a row of blanks, because the moment the end of a row has been reached the action of the carrier is automatically reversed and the next row may be punched as the carrier returns to the starting point.

STEEL-MAKING BY DIRECT PROCESS

The larger portion of the steel-making pig iron is transported in molten condition from the blast furnace to the steel mill and is never marketed in the form of pig iron at all. Similarly, during the initial stages of rolling steel products, the ingots, blooms, and slabs are merely intermediate stages in the production of steel and not ordinarily commercial products. Thus, before the ingot has lost the heat acquired in producing the steel itself, it has been rolled into a bloom, a slab, or a billet and is ready to be rolled into some finished rolled product, such as rails, plates, or structural shapes. This saving of heat and the use of automatic machinery in handling these heavy rolled products keep down the fuel and labor costs; therefore, the prices of the heavy products are largely controlled by the cost of the crude steel. But in the case of light-rolled products, such as wire rods and sheets, more rolling is required, with a corresponding loss of heat and greater use of hand labor; therefore, the prices of light-rolled products are largely influenced by the fuel and labor costs.

RATE OF EVAPORATION

The weight of dry steam evaporated in a boiler per pound of coal is called the *rate of evaporation*. This rate varies with the character of the heating surface and its relation to the grate area. In power boilers of good design, the rate of evaporation generally varies from 9 to 10 pounds, while in the case of heating boilers, it is more commonly 7 or 8 pounds.

RIVET SPINNING

Riveting machines that spin rivets, pins, and other fastenings by a pair of rapidly revolving rolls are provided with rolls carried in a holder in which they are free to revolve while they are pressed against the rivet or pin as the machine spindle rotates at high velocity. The revolving rolls cause the metal to spread and assume the proper form of head. The rolls may be made with flat, concave, or angular faces to suit the shape of head desired; also special shapes may be employed. The machines are built in either the vertical or horizontal style, in both of which styles the arrangement of rolls and their action is the same. One feature of these machines is the absence of noise which is characteristic of hammer-riveting. "Rivet spinning"—in the general meaning of the term—includes spinning heads on pins, studs, and bushings, as well as rivets.

ROTARY FILES

Files of the rotary type are made in either cylindrical, conical, spherical, concave, or special shapes for finishing the edges or surfaces of punches, dies, metal patterns, and various other classes of work. The file may be rotated by inserting it in a drilling machine spindle, as for finishing the edges of punches or dies, or by using a flexible shaft drive, as when the position of the file must be varied by hand control.

BELT GRIP AND TENSION

"Belt grip" and "belt tension" are two terms that are frequently confused. A belt can be made to grip a pulley effectually by increasing its tension, but this throws an undue strain on the driving shafts and often causes hot journals. On the other hand, belts that are properly treated with suitable dressings can be made to grip the pulleys effectually even though running slack. The importance of grip as distinguished from tension cannot be too fully appreciated. Some are of the opinion that when a belt fails to transmit the required power it should have its tension increased by tightening. The effective pulling power of a belt is the difference in the tension on the slack and tight side. It is obvious that the greater the grip of the belt on the pulley, which increases proportionally with the arc of contact, the greater power it will transmit. It follows, therefore, that a belt running slack, provided it grips the pulley effectively, will give a better grip over a greater arc of contact than a tight belt, and that at the same time the loss of power due to friction will be reduced. Some forms of belting possess less elasticity or resiliency than others and thus transmit power more by sheer weight and tension than by gripping power. The limit of the decrease of the tension value on the slack side of a belt is at that point at which the belt slips on the pulley, the maximum pulling power being attained at the moment preceding the slip. From this it follows that the value of a pliable belt lies in the fact that the tension on its slack side may be decreased to a much greater extent than is the case with a hard belt before slipping becomes evident.

MACHINERY'S SCRAP-BOOK October, 1924

CYCLE OF AN ALTERNATING CURRENT

"Cycle," as applied to alternating current, refers to that period of time in which the current builds up from zero to its maximum, then drops gradually back to zero, and passes through the same increase and decrease in the opposite direction. Thus there are two alternations for each cycle. By the "number of cycles," that is, 60, 50, or 25, is meant the number of complete cycles per second. In other words, for a 60-cycle line there are $60 \times 60 \times 2 = 7200$ alternations per minute.

CASEHARDENING

Briefly defined, casehardening is the process of hardening the "case" or surface of low-carbon steel by first increasing the carbon content of the surface. The object is to raise the carbon content of the surface until it may be hardened by the usual method of heating to a hardening temperature and quenching in a cooling bath. Hence, the term "casehardening" implies the hardening of the surfaces or skin of a part made from steel. The process of increasing the carbon content of the surface is known as "carburizing," and the actual hardening process is known as "casehardening." The carbon content is increased by heating the steel in the presence of materials high in carbon, so that the latter element which has a great affinity for iron, has an opportunity to combine with it in the surface of the steel. The materials used for carburizing steel are known as "carburizers." Carburizing material, in general, is a carbonaceous material, which gives off as its chief ingredient carbon monoxide gas. Other gases given off are really impurities. Charcoal, coke, or anything that burns to charcoal or coke when burned with a minimum amount of air is really a carburizer. Alone, however, these materials are not suited for all cases of carburizing, inasmuch as the carbon monoxide gas is not controllable in its volume given off and its intensity. Usually chemicals or a catalytic agent is added to the carburizer or to the coke or charcoal product which is known as the "generator," and this chemical or catalytic agent has been termed an "energizer." The energizer, therefore, is some product which regulates the volume and intensity of the gas given off by the generator, but which, in itself, does not take a definite part in the actual carburizing operation.

HOBBING DIE IMPRESSIONS

The hobbing or hubbing process has long been employed for making dies such as are used in producing coins, medals, and various products of the silversmithing and jewelry trades. This method is designated as hobbing or hubbing, because a "hob" or "hub" is used, which is in the form of a punch and has a shape corresponding to the impression required in the die. This hob (as it will be referred to here) is also known as a "force." The hob, at its formed end, is a duplicate in hardened tool steel, of the part to be made in the die. While this hob must be made accurately and be given a fine finish, it is, of course, much easier to produce than would be a cavity or impression of corresponding shape. Furthermore, after the hob is made, it can be used to advantage in reproducing duplicate impressions in a number of different dies. The hob is hardened so that it will withstand the extremely high pressures employed in connection with the production of dies by this method. In a general way, the method consists in forcing the hob into the unheated die blank by means of hydraulic power, so that the shape of the hob is reproduced in the die impression.

GUTTA-PERCHA

Gutta-percha is derived from the secretions of the bark of certain trees found in the Straits Settlements and the Malaccan Archipelago. At temperatures between 32 and 80 degrees F., it resembles dark brown leather; at temperatures above 80 degrees F., it softens; and at 150 degrees F., it becomes plastic and can be molded. Upon cooling, it again becomes non-plastic. It oxidizes when exposed to the air, changing its color and becoming brittle. The chief use of gutta-percha is for electrical insulating purposes. It appears in commerce in the forms of blocks or cakes of a grayish appearance. When used for insulation, it is shredded into warm water, kneaded, strained, and rolled into sheets. It is applied to the wire that is to be insulated by special tubing machines, or wound upon the wire in the form of strips. Gutta-percha may be used as an insulating material in the pure state, without admixtures of any kind. It is less porous than rubber, and is therefore more waterproof. For this reason, it is the best material to use as an insulation for submarine cables. Its specific gravity is almost exactly equal to that of water.

ADMIRALTY METAL

The name "admiralty metal" is given to an alloy consisting of 87 per cent copper, 5 per cent zinc, and 8 per cent tin. It is used for parts of engines and machinery on board ships, especially in naval construction. An alloy also known by this name, used for surface condenser tubes where seawater is used for cooling, is composed of 70 per cent copper, 29 per cent zinc, and 1 per cent tin.

WOOD SEASONING PROCESSES

There have been differences of opinion as to whether kiln-dried wood is as strong as wood that has been air-dried. In order to determine the relative properties, the Forest Products Laboratory of the United States Forest Service at Madison, Wis., made some 150,000 comparative strength tests on specimens from twenty-eight different common species of wood. The results of these experiments showed conclusively that good kiln-drying and good air-drying have the same effect upon the strength of wood. The belief that kiln-drying produces stronger wood than air-drying is usually the result of failure to consider differences in moisture content. The moisture content of wood, on leaving the kiln, is usually from 2 to 6 per cent lower than that of thoroughly air-dried stock. Since wood increases in strength with loss of moisture, higher strength values may be obtained from kiln-dried than from air-dried wood; but this difference in strength has no practical significance, since eventually a piece of wood will come to approximately the same moisture condition, whether it is kiln-dried or air-dried.

VACUUM CHUCKS

For holding pieces made of various magnetic and non-magnetic materials on grinding and milling machines, shapers, planers, lathes, etc., vacuum chucks are used in essentially the same manner as magnetic chucks are employed for holding pieces made of iron or steel. The upper surface of a vacuum chuck consists of a flat plate perforated with small holes leading to an inside chamber which is coupled up to an exhaust tank. The high vacuum in this tank is maintained by means of a vacuum pump. Each chuck is supplied with a control valve, and as a result, the vacuum chuck is controlled by manipulating a valve in the same way as the magnetic chuck is operated by an electric switch.

NEW TYPE OF ANGULAR TRANSMISSION

By G. M. BARTLETT

If a designer is seeking a means for transmitting power between two shaft ends at right angles where the four requirements are positive motion, flexibility, compactness, and quietness of action, what form of mechanical motion will he adopt? A survey of the small group of mechanisms available for angular drives will reveal a rather meager list from which to choose. There are angular transmissions that are positive and compact, but are neither flexible nor quiet. There are transmissions that are flexible and quiet, but neither positive nor compact. It may reasonably be assumed, then, that a description of any new mechanical movement that meets all these requirements will be of interest both to designers and power transmission engineers.

In Fig. 1 is shown a Bartlett angular transmission used as a substitute for a pair of miter gears on an automatic wire-forming machine. In this particular case, the machine

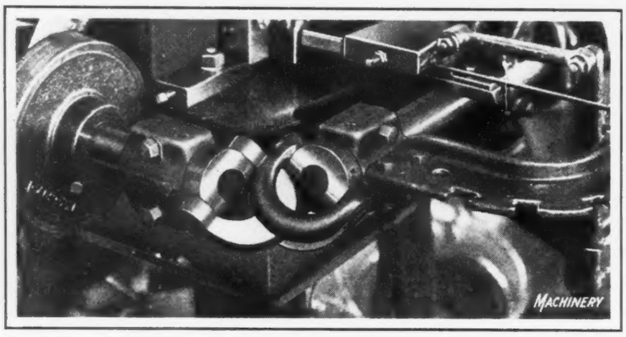


Fig. 1. Angular Transmission applied to Automatic Wire-forming Machine

was originally equipped with bevel gears, but the bearings were not in perfect alignment and the gear teeth developed rapid wear and several breakages within a few months. The drive that replaced these gears forms a flexible connection between the shaft ends and operates silently and efficiently even with one shaft slightly higher than the other. After seven years of service the parts show very little wear.

When used as a right-angle drive for lineshafting, as in Fig. 3, the drive is connected direct to the shaft ends, which are preferably mounted in self-aligning bearings secured to a special hanger. This hanger provides a rigid connection between the bearings and allows for adjustment in all directions. It also provides a convenient surface on which an oil-case of simple design may be attached.

The use of the drive is not confined to right-angle transmissions, but is applicable to any shaft angle from 0 to about 120 degrees, although at the latter angle the contact between the rubbing surfaces would be considerably reduced. If the shaft ends are swiveled, as in Fig. 2, a complete angular sweep of 180 degrees, or 90 degrees in either direction, is possible; and by adding a ring and a second swivel-pin,

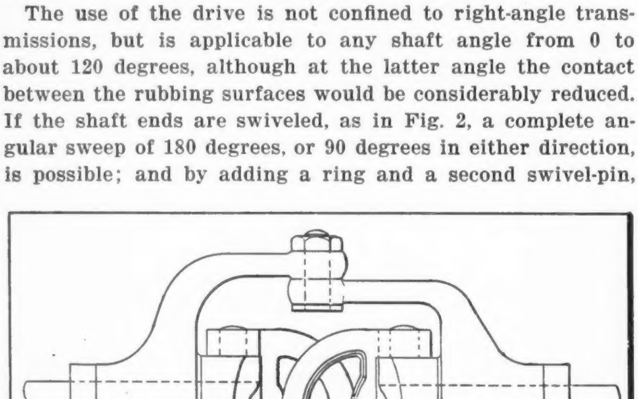


Fig. 2. Transmission with Swiveled Ends

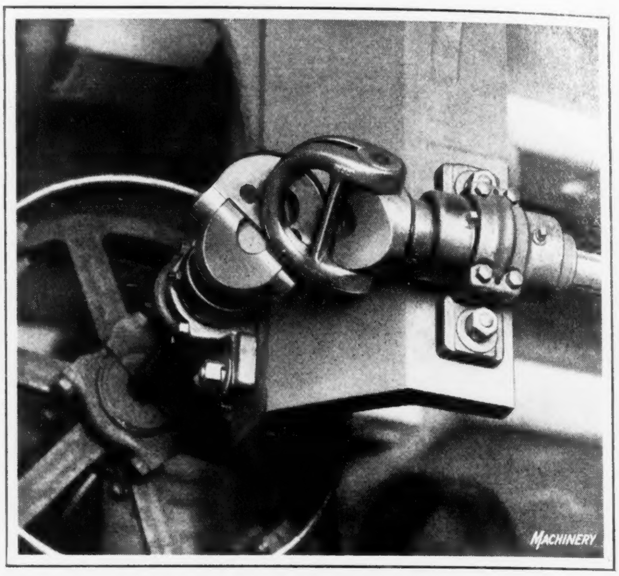


Fig. 3. Lineshaft Right-angle Drive

a universal joint of a hitherto unattainable magnitude of angular sweep may be produced. Such a universal joint has the unusual property of maintaining a uniform angular velocity ratio of 1:1 between the driving and the driven shafts. It is well known that the common type of universal joint produces an increasing departure from a uniform ratio as the shaft angle increases; for example, with a shaft angle of 30 degrees, Hooke's joint causes a total variation of about 8¼ degrees between the two shafts twice in each revolution,

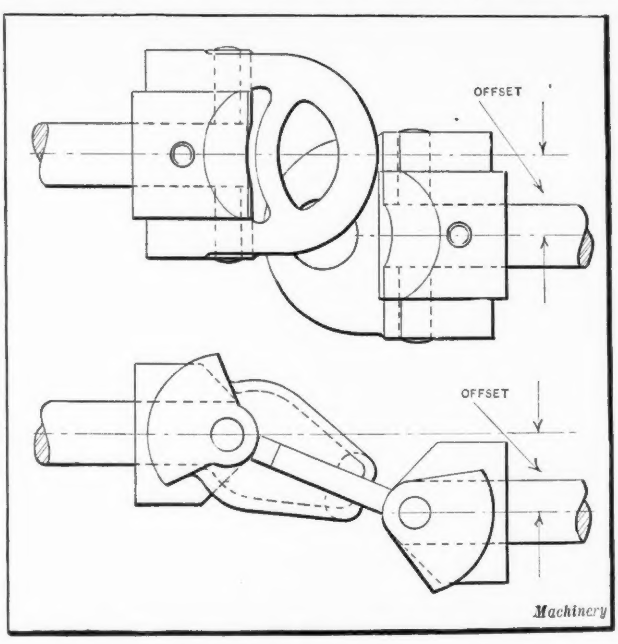


Fig. 4. Diagrams showing Drive employed on Offset Shafts

and the actual variation from uniform angular velocity is 28.87 per cent.

Where the shafts are parallel, but considerably offset, this drive can perform the same function as the well-known Oldham coupling, the angular velocity ratio still being uniform. Two positions of the drive when used in this way are shown in Fig. 4, where the positions in the two cases differ by a quarter of a revolution of the shaft.

From Fig. 5 it is possible to obtain a good idea of the construction and action of the parts when the transmission is used for a right-angle drive. The two hubs *A* are keyed to the shaft ends. Each hub carries two hardened steel pins *D* over which the driving members *B* and *C* are free to turn through an angle of somewhat more than 45 degrees on each side of the shaft axis. The member *C* is of cast iron, semi-steel, or bronze, and is slotted as shown to pro-

vide a sliding fit for the member *B*, which is of steel with the working surfaces hardened and ground. The openings in the semicircular parts are for the purpose of reducing the weight, and the extra metal on the opposite side of the pins acts as a counterbalance, but is not needed except for high speeds.

For a perfectly uniform angular velocity ratio, the following conditions must exist:

1. The center line of each pin must intersect the axis of the shaft.
2. The center lines of the pins must lie in the mid-plane between the sliding surfaces of the tongue and slot.
3. The axes of the two shafts must intersect in a point *E*.
4. The center lines of the two pins must be equally distant from the intersection *E* of the shaft axes.

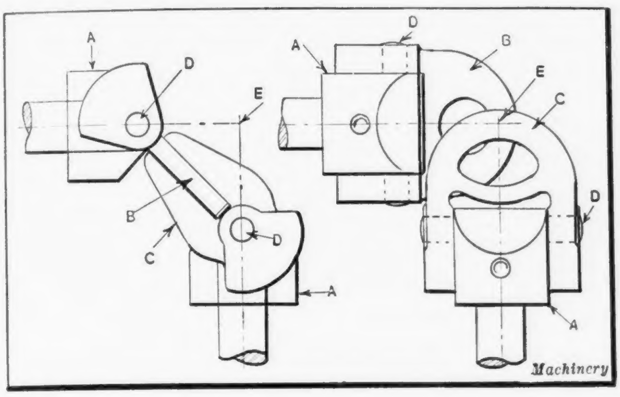


Fig. 5. Transmission used for Right-angle Drive

If these four conditions hold, it must follow that for all positions of the sliding members, the center lines of the two pins lie in the same plane, which is the mid-plane of the tongue and slot. Also this mid-plane is always inclined at equal angles with the axes of the two shafts. Hence any angular motion of one shaft must be accompanied by an equal angular motion of the other shaft.

While deviation from the four conditions mentioned will affect the uniformity of the velocity ratio to some extent, it is not necessary to hold to the same degree of precision in mounting these units as would be required for gears.

This drive is actually a flexible shaft coupling applied to shafts whose axes are set at angles varying from 0 to 90 degrees. When the shafts are not in perfect alignment, the bearings are relieved of undue stress, and the action is smooth and quiet. Shaft misalignment is not possible with gears, nor, in general, with most other types of angular drives. Indeed it has generally been considered bad practice to connect an angular transmission directly to the shaft ends. It is usually placed at a distance from both shafts and connected to each with belts and pulleys. The expense of this arrangement, as well as the additional space required for its installation, has created a demand for a new type of angular drive. Such a drive as is here described will, therefore, be of some interest to those who have hitherto been obliged to resort to roundabout methods of transmitting rotary motion around a corner silently, positively, flexibly, and economically.

* * *

COURSE IN INSPECTING METALS

Polytechnic Institute of Brooklyn, Department of Mechanical Engineering, announces a new special course beginning February 2, 1925, in the inspection of engineering metals. This course will be given in the evenings so that it may be attended by men regularly employed in the daytime. The course will cover the metallurgy of cast iron and steel, copper, brass, and bronze, and will deal with the heat-treatment and mechanical treatment of metals, and the common methods of testing materials. Further information may be obtained by applying to the director of the Evening Department, Polytechnic Institute of Brooklyn, 99 Livingston St., Brooklyn, N. Y.

CLOSING TUBE ENDS BY SPINNING AND WELDING

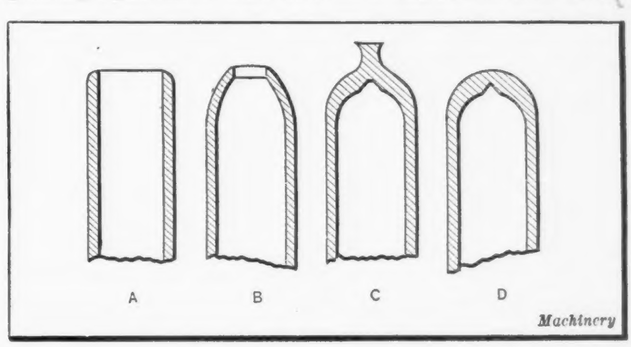
By J. COLOMBET

The most interesting job the writer has ever seen performed on an engine lathe was the closing of the ends of boiler tubes by simultaneous spinning, heating, and welding. The ends of the tubes were required to be closed in a half-spherical form. The material was of the best quality cold-drawn steel tubing, about 2¾ inches in diameter with a wall thickness of approximately ¼ inch. While metal-spinning is a process that has long been employed, the combining of the mechanical action of spinning with heating and welding to close the end of a tube in one operation is a comparatively new idea.

An old medium-duty engine lathe having a hollow spindle, and a specially designed chuck for holding the tubing and at the same time insulating the spindle from the heat produced in the tube while being spun, were employed for the job. The tubes were cut to a length slightly greater than that called for by the finish dimensions, and the outer edge of the end to be closed was turned to a radius, as shown at *A* in the illustration. To speed up the spinning, the end of the tube was heated to a dark red before being put in the machine chuck, where it was rotated at a high speed.

The forming or spinning tool was a blunt-ended piece of high-speed steel, mounted on the cross-slide by means of a special attachment which permitted it to be swung in accordance with the radius to which the closed end of the tube was to be formed. First the spinning tool was brought into contact with the walls of the tube and swung around. This operation was repeated, the tool being moved forward step by step after each swinging or sweeping operation, until the end of the tube was closed to a half-spherical shape. The heat produced by the friction of the tool against the metal increased the temperature, and as the metal was forced closer and closer toward the center, where it thickened as the diameter diminished, the heat became so intense that it melted the metal. At that point the tool was swept across the end so that a perfect weld was obtained.

With the method described, the tube passed through three stages, as indicated at *B*, *C*, and *D*. The view at *B* shows the end of the tube as it appeared at the beginning of the spinning operation. The view at *C* shows the end of the tube with the metal forced in toward the center, so that it forms a button-like projection which is so hot that a final sweep of the tool will weld over the end of the tube and remove the button-shaped portion, leaving the end spherical in shape, as indicated at *D*. About 30 horsepower was required to drive the lathe when performing this operation, and the spindle speed was approximately 4000 revolutions per minute. The time required for the complete operation of closing the end of one tube was only three minutes.



Diagrams showing Work at Various Stages of Tube-closing Operation

* * *

The charge is often leveled at the automobile that it is an extravagance as well as a breeder of extravagance. A few decades ago the same statement was made in connection with the bath tub and the telephone.—*Alvan Macauley, President, Packard Motor Car Co.*

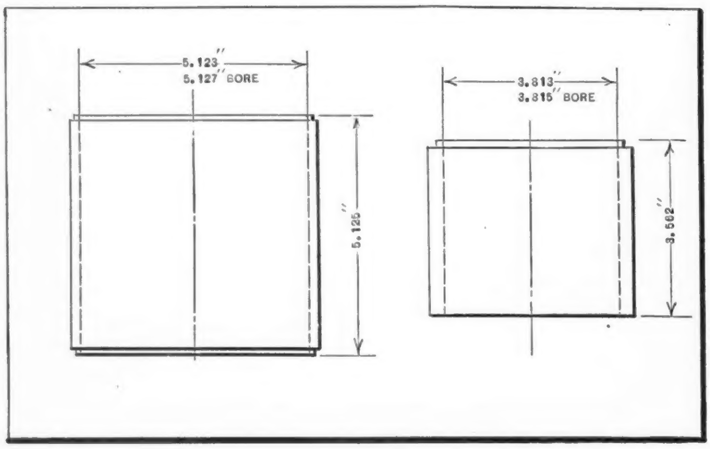


Fig. 3. Two Generator Frames which are bored and reamed to Size on Heavy-duty Vertical Drilling Machines

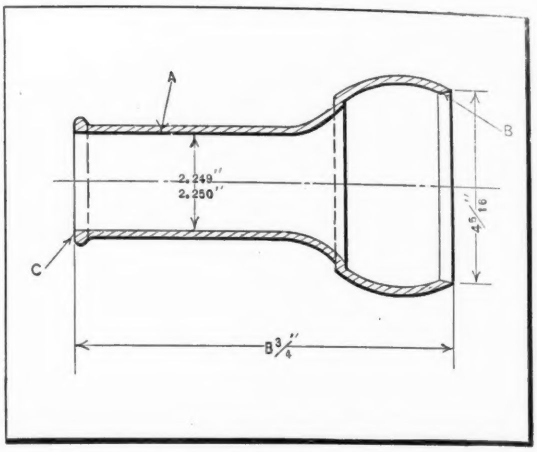


Fig. 4. Universal Joint Ball in which Two Holes are bored and One Surface faced and rounded

Two generator frames bored on heavy-duty vertical drilling machines are shown in Fig. 3. The one on the left-hand side is made from a piece of steel tubing, while the frame on the right-hand side is a malleable-iron casting. Before coming to the machines on which the boring is done, these frames are faced square with the rough bore to permit the part to be chucked endwise. This method of holding obviates squeezing in the walls of the parts, which might occur if the frames were chucked from the outside cylindrical surfaces. The frame at the left is handled on two single-spindle machines, and the production from the two machines, operated by one man, averages 33 parts per hour. The malleable-iron generator frame is handled on a three-spindle gang machine tended by one operator. On this machine are used combination boring-bars which carry a roughing cutter followed by a floating reamer. With this equipment the production obtained is 120 parts per hour.

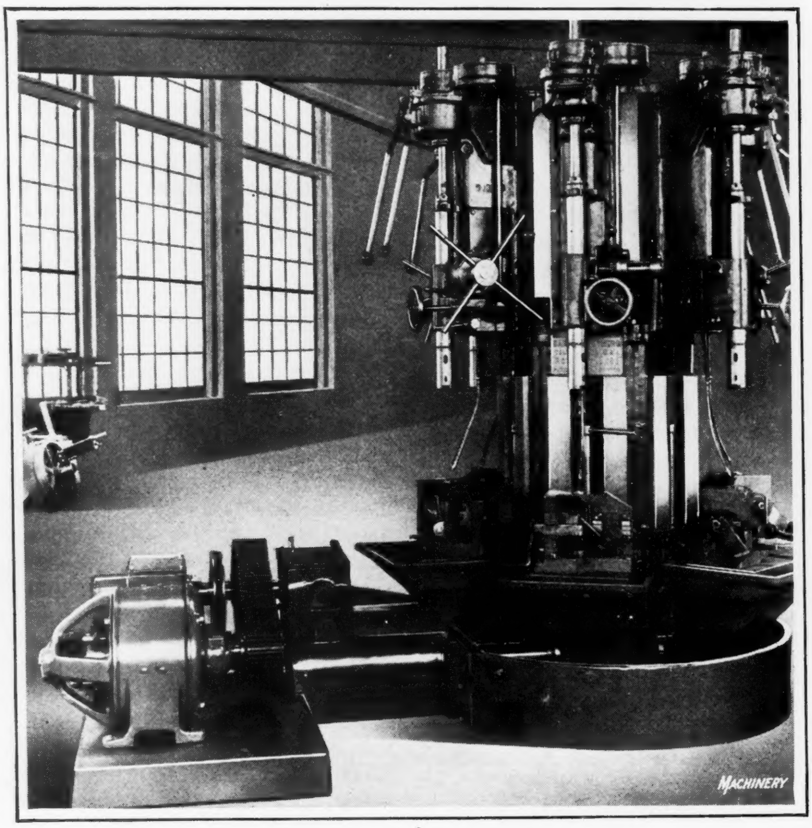


Fig. 5. Rotary Drilling Machine for drilling and reaming Automobile Steering Knuckles

Bore *A*, bore *B*, and surface *C* of the malleable-iron universal joint ball shown in Fig. 4 are also finished on drilling machines. The boring of hole *A* is done on a single-spindle machine with the part held in a two-jaw floating chuck. It is bored to a depth of 5 1/4 inches at a speed of 204 revolutions per minute and a feed of 0.060 inch, the production averaging 120 parts per hour. Bore *B* and face *C* are finished on a three-spindle gang machine tended by one operator, and a production of 80 parts per hour is obtained.

In Fig. 6 are shown two drop-forged universal joint yokes. The one on the left-hand side has a hole *A* drilled 15/16 inch in diameter to a depth of 1 1/2 inches, while the yoke on the right-hand side is faced on surface *B* and turned on surface *C*. Hole *A* is drilled in a single-spindle machine at a speed of 229 revolutions per minute and a feed of 0.016 inch. The production is 110 parts per hour. The turning and facing steps on the second yoke are also performed in a

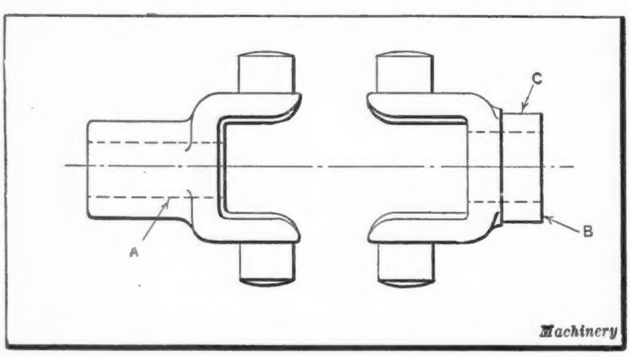


Fig. 6. Universal Joint Yokes which are drilled, faced, and turned

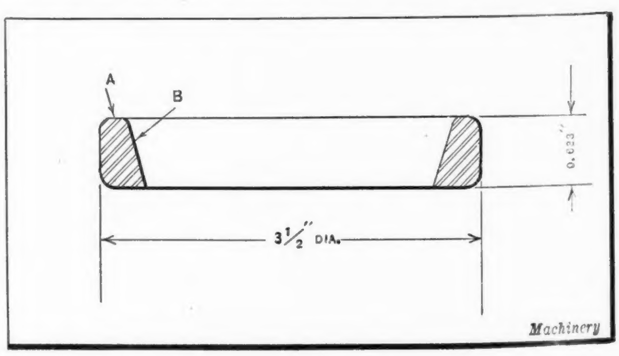


Fig. 7. Roller Bearing Race which is taper-bored, faced, and rounded

single-spindle machine with the spindle driven at a speed of 167 revolutions per minute and a feed of 0.012 inch. In this step the production averages 120 parts per hour.

In Fig. 7 is shown a roller bearing race which has surface *A* faced and rounded, and surface *B* taper-bored on a single-spindle machine equipped with a special supporting bracket to insure a rigid support for the tools. The work is held in a universal three-jaw chuck, and a hand feed is employed for the operation, finishing to a depth stop. The part is a steel stamping, but the metal cuts freely after the scale has been cut through. With a spindle speed of 101 revolutions per minute, the production of one machine tended by one operator averages 110 races per hour.

* * *

ASSEMBLY DRAWINGS VERSUS DETAILS

By E. H. FISH

The most common practice in drawing-rooms is to lay out a design on manila paper, trace it for an assembly drawing, and make details of the individual parts with full dimensions and whatever may be needed in the way of instructions. Very often the tracing of the assembly drawing is left until after the first lot of machines is completed and all the changes that appear necessary are made. Some of the older machine tool shops work entirely from assembly drawings, fully dimensioned, and with all necessary directions except those that are obvious to men who have worked in machine tool shops.

The older method, the latter of the two cited above, has certain undeniable advantages under favorable conditions. If this method is to give the best results, the workmen must be accustomed to building the kind of machines on which they are to work. It involves their rather definite division into gangs, each gang working on units, such as lathe headstocks, planer heads, milling machine dividing heads, and so on. It also involves building machines rather than manufacturing them.

In a shop where each part is made to limits and inspected independently of the part with which it is to be assembled, it is obvious that the use of assembly drawings only will not be satisfactory, while in a shop where each piece is fitted to its place with only a sufficient approach to interchangeability to make repair parts possible, this system can be used with good results. It is evident that it is rather expensive to make detail drawings, and to keep them up to date, with the numberless minor changes that experience indicates are desirable. If an assembly drawing is used, one change of a dimension changes the drawing for one part and also for the part with which it is assembled. If details are used two drawings have to be found and changed, and sometimes one is forgotten, with the consequent loss of labor and material.

Since it is inevitable that many machine shop products will always be "built" in distinction to being "manufactured," and that special changes are almost the rule in many shops, is it not wiser to sacrifice strict interchangeability, and proceed to look on the shop as an engineering institution rather than a manufacturing one, and pursue the line of least resistance by using assembly drawings in the shop? We should bear in mind that if we are to train our apprentices to be capable machinists instead of looking to other plants to furnish our skilled workmen, we must encourage and inspire them by at least letting them see what it is they are building and where it goes in the machine. This they cannot see from a detail drawing.

* * *

EXPOSITION OF CHEMICAL INDUSTRIES

It is announced by the International Exposition Co. that there has been some misunderstanding relating to the dates of the Tenth Exposition of Chemical Industries. This exposition is to be held in the Grand Central Palace, September 28 to October 3, 1925, instead of this year as previously announced.

ARE PRODUCTION COSTS OF MACHINE TOOLS GOING DOWN?

By ERNEST F. DuBRUL

General Manager, National Machine Tool Builders' Association

In answer to the question as to whether production costs of machine tools are going down, the following is the writer's judgment, gathered from conversations in various parts of the country and from knowledge of the situation in Cincinnati. The year 1914 was a year of depression, and not many apprentices were started in the machine tool shops that year. Then the war demand came on in such volume as to permit the machine tool industry to train and use specialized operators who were broken in on single operations. It did not have time to go on with general apprentice training. All through the war period up to the slump of 1921 there were not a great number of apprentices started through the shops. The slump of 1921 dissipated these forces. Many of our machinists and most of our handy-men were absorbed by other industries whose demand came back more rapidly than the machine tool demand did. Naturally, during all the depression from 1921 to date the machine tool industry did not train mechanics. For ten years we have not been training mechanics.

The necessary cost of training new men will inevitably add to the cost of the machines to be made in the future. The untrained men will not be as efficient as the same number of trained men. The untrained men will require more supervision, which, with many other expenses, will tell a sad story on the cost sheets. As soon as there is a fair demand for machine tools with a depleted labor market, the builders must bid against their customers for available labor. It does not appear that all other mechanical industries have trained so many machinists that the machine tool builder can step right out and pick them up over night. It does not seem that machine tool shop operation has been so simplified in the last ten years that more unskilled labor can be used when production is on a small scale.

Besides this situation as to labor, the machine tool industry is confronted with a very serious problem as to overhead. With the greatly reduced demand prevalent since 1921, the machine tool industry on the whole has not recovered its out-of-pocket expenses for overhead. Cash reserves were decidedly depleted, and many companies have had to withdraw from the machine tool business entirely. In some cases machine tool builders have taken other products to manufacture in their shops, so that a certain amount of present capacity will not again be devoted to the machine tool industry; and there have been consolidations which have eliminated some capacity.

If the rate of demand continues low, decimation of productive facilities will continue, either voluntarily or involuntarily. It seems quite likely, therefore, that the next rise of business will find a shortage of machine tool capacity. Producers buying at such times are not able to supply their wants as readily as they would like, and they will find themselves compelled to pay higher prices for the use of the limited capacity.

After all the agitation and discussion that has been going on regarding the effect of business cycles, it is strange that very few large, well-financed companies see that it is to their direct interest to make machine tool purchases when business is dull. Every economic service points out that this is the proper policy to pursue. Many large institutions have the money to buy, and could easily forecast their needs of equipment. But very few of these concerns are buying what they are going to need in a very few months. A few managers have been looking ahead and placing orders. They know they are not likely to get the tools they need any cheaper than they can get them right now, with the conditions ruling in the machine tool market. True, such buyers are very few, but these few are the wise ones. They are getting just what they want, at prices lower than present costs of production. Later on, the unwise will be paying the losses that are now borne by the machine tool builder.

Unusual Engine Lathe Operations

Prize-winning Articles in MACHINERY's Contest on Interesting Lathe Practice—Fourth Installment

CAM GROOVE PLANING IN THE LATHE

By H. C. TEN HORN

Some time ago the writer had to make ten cast-iron plates like the ones shown at *A*, Fig. 1, which were required to have a groove *B* of special form planed in the side. As the planer in the repair shop was in use and the work was needed at once, the writer decided to rig up an engine lathe to handle the job. First the tailstock was placed at the right distance from the headstock for holding the work on centers. A bolt *C* and two plates *D* and *E*, as shown in Fig. 2, were used to hold the work in a stationary position between the centers. Then the driving nut on shaft *F* was removed so that the cross-slide was free to move back and forth. The compound slide *G* was next removed from the cross-slide and mounted on the carriage in a vertical position, a piece of angle-iron *H* being used for this purpose.

A templet *J* made from an oak plank was secured to the back side of the lathe, as shown in the end view, Fig. 3. The rear edge of the templet was cut to conform to the shape of the groove required in the work. A steel rope *K*, one end of which was attached to a weight *L*, was secured to the front end of the carriage cross-slide so that the weight would bring roller *M* in contact with templet *J*. Roller *M*, it will be noted, is secured to the carriage cross-slide by means of a heavy strap or bracket *N*. With this arrangement it is evident that the tool *T*, Fig. 1, held in the toolpost of the compound rest, will follow a path corresponding to the profile of the templet *J* when the lathe carriage is traversed back and forth between the headstock and the tailstock. An automatic stop *S* was employed at the headstock end of the lathe to prevent the carriage from

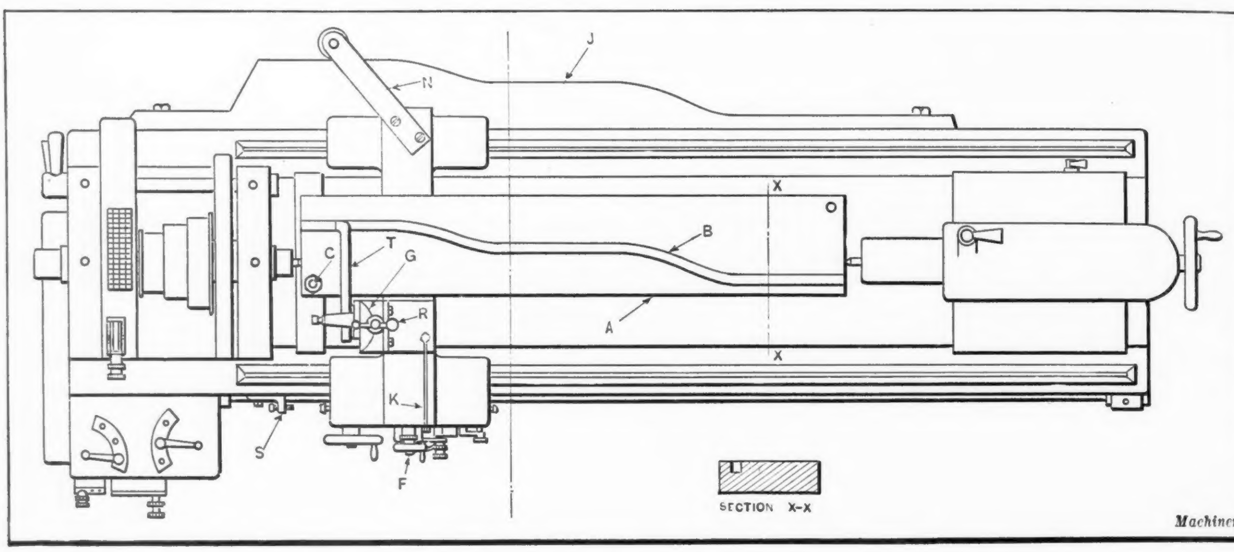


Fig. 1. Plan View of Lathe arranged for planing Cam Groove

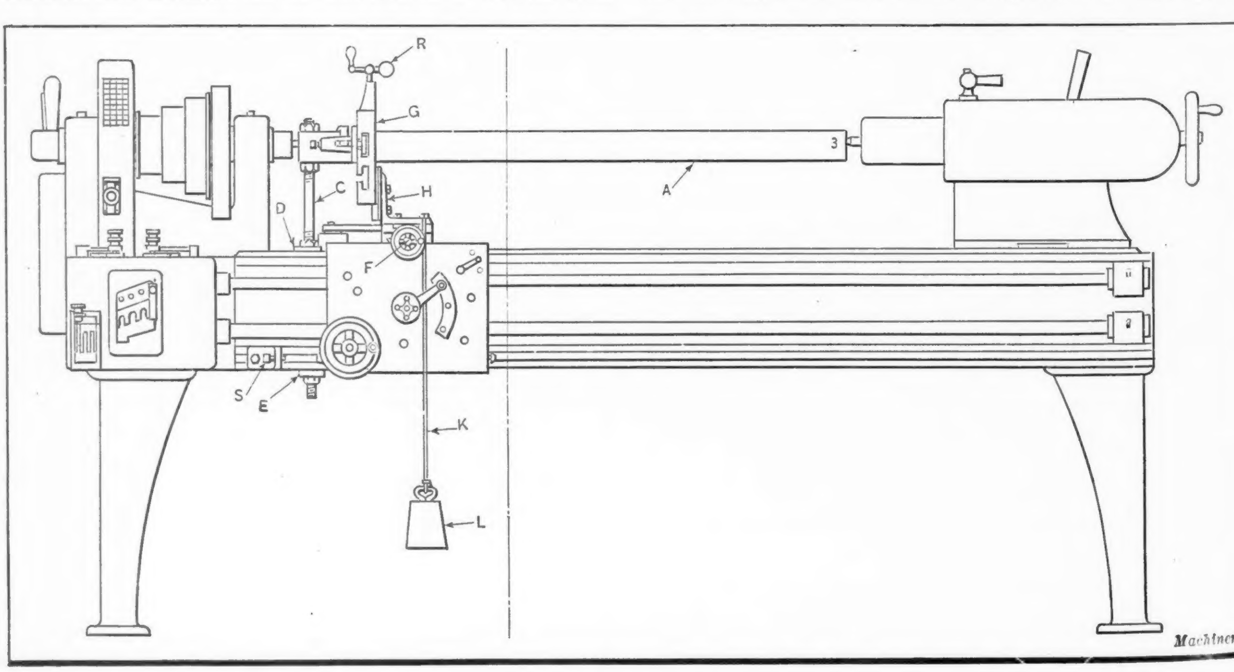


Fig. 2. Front View of Lathe shown in Fig. 1

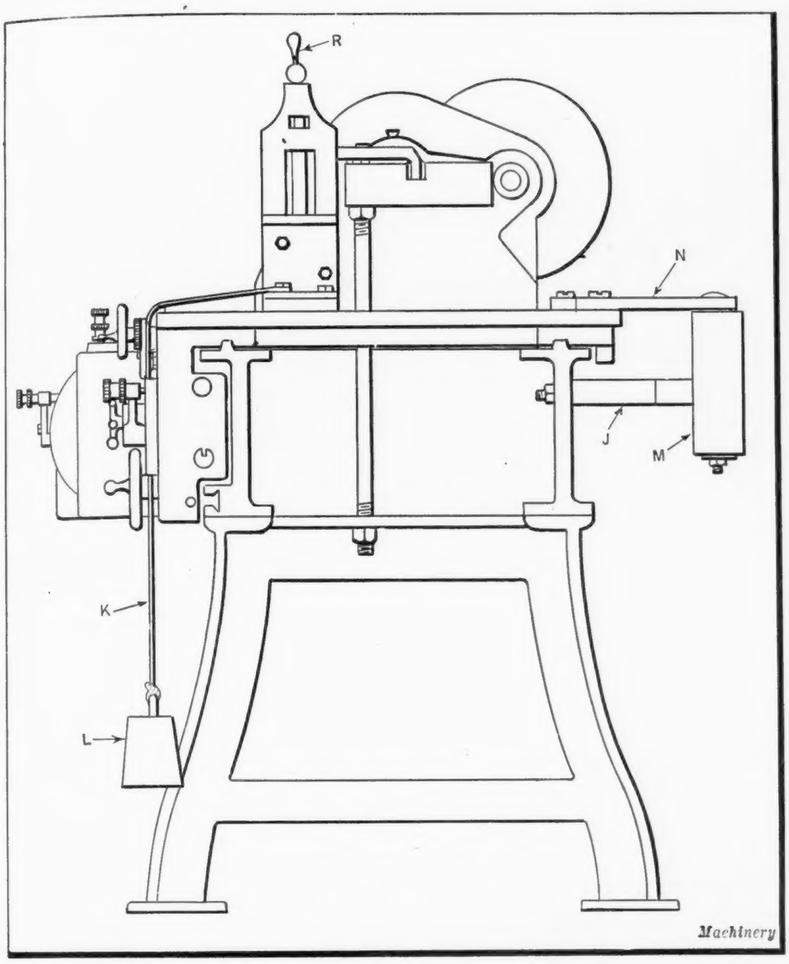


Fig. 3. End View of Lathe shown in Figs. 1 and 2

being fed so far to the left as to damage or change the setting of the work. After setting all the control handles in their proper positions, the driving belt was shifted over until a speed was obtained that gave the carriage a traverse speed suitable for planing the groove *B*.

The tool was fed in for each cut by turning the handle *R*. The cutting end was made the same width as the required groove, so that the only adjustments or feeding movement required when the first cut had been taken was the downward feed of the tool after each return traverse of the carriage.

CUTTING INTERNAL OIL-GROOVES

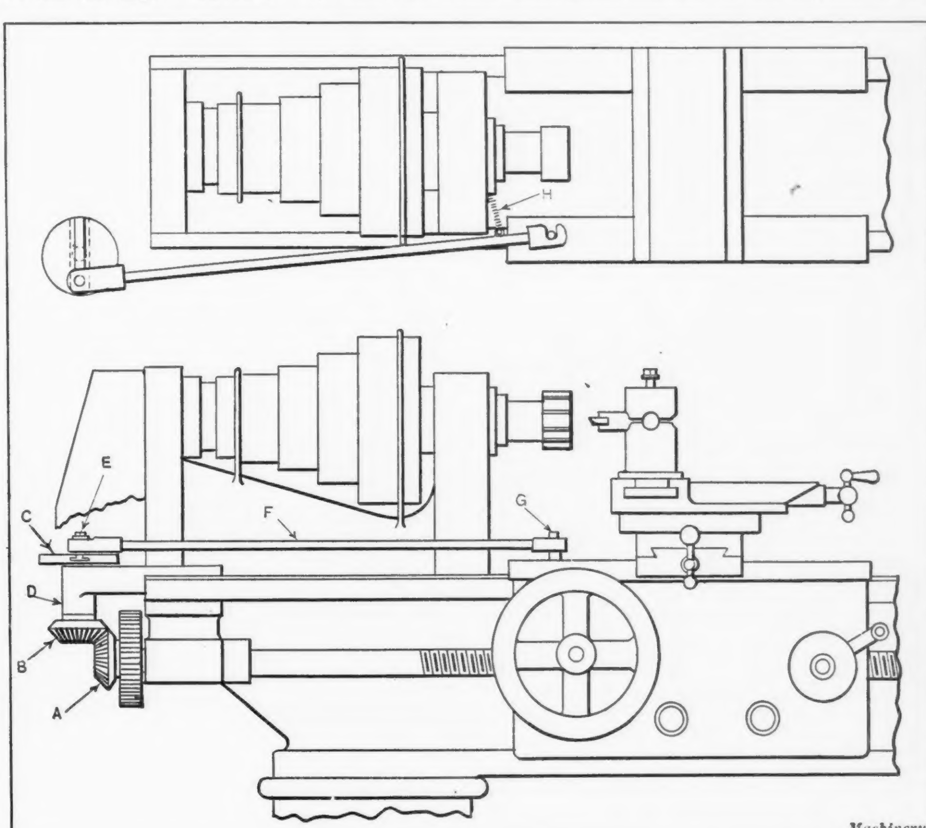
By FRANCIS M. WESTON, Jr.

By an inexpensive adaptation, an ordinary engine lathe can be fitted to cut internal oil-grooves as well, and almost as quickly, as the special machinery designed for the purpose. The accompanying illustration shows an elevation and a partial plan of a small lathe thus equipped. One of a pair of miter gears *A* and *B* is fitted on the outer end of the lead-screw of the lathe, while the other is mounted on a short stub shaft carrying on its upper end a crank disk *C*. This stub shaft is supported in a bracket *D* bolted to the bed of the lathe. A crankpin *E*, adjustable in the T-groove of the crank disk, drives a link *F* which hooks over a wrist-pin *G* on the tool carriage. A tension spring *H*, secured to the headstock of the lathe below the spindle, keeps the hook in place on the wrist-pin, but permits it to be easily disengaged from the carriage while work is being set up or taken down.

In operation, the position of the adjustable crankpin is set so that its throw equals the length of the oil-groove to be cut. The gear ratio between the spindle of the lathe and the lead-screw is adapted to the type of oil-groove being handled. A 2 to 1 ratio, for instance, gives the usual "figure eight" groove, while a ratio of 4 to 1 gives a double "figure eight," etc. The revolution of the crank disk moves the carriage and tool back and forth, while the tool is fed into the work by hand. For soft brass or babbitted bearings, three or four travels of the tool are usually sufficient to cut a groove of the desired depth. A round-pointed boring tool is found to be satisfactory for this work.

The fact that a lathe has been adapted for oil-grooving does not disqualify it for ordinary work, because the disconnection of the link removes all interference with the regular equipment. When a large quantity of bearings or bushings are to be grooved, however, and a lathe can be permanently set aside for this purpose, it is advisable to remove the apron of the tool carriage in order to reduce the weight of the moving parts as much as possible.

For quantity production on small bushings, it has been found convenient to hold the work in a spring collet. Considerable time is saved in setting up or tightening the collet by using an 8-inch handwheel secured to the cap-nut of the



Lathe equipped for cutting Internal Oil-grooves

collet instead of the usual spanner wrench. A quick knock-out bar operated by a lever on the outer end of the head-stock also proves a time- and labor-saver. When bushings of the same size are to be grooved in large quantities, the work can be done by an unskilled workman after the machine has been set up by an experienced machinist.

Some idea of the production may be obtained from the fact that a lot of several hundred brass wrist-pin bushings for a gas engine 2 3/4 inches long by 1 3/16 inches inside diameter, were grooved with a figure eight at the rate of twenty pieces per hour. This includes the time taken to set each bushing in the spring collet, cut the groove, and release and knock out the bushing. A lathe equipped as described is particularly well adapted for service in a small shop where the number of bearings grooved in a year does not warrant the purchase of special machinery designed for the purpose.

TWO LATHES USED FOR ONE JOB

By A. L. PASCHALL

Our factory recently had an unusual turning job to do. It was necessary to bore out the inside of some bowls to be used on a type of meat chopper commonly called a "Silent

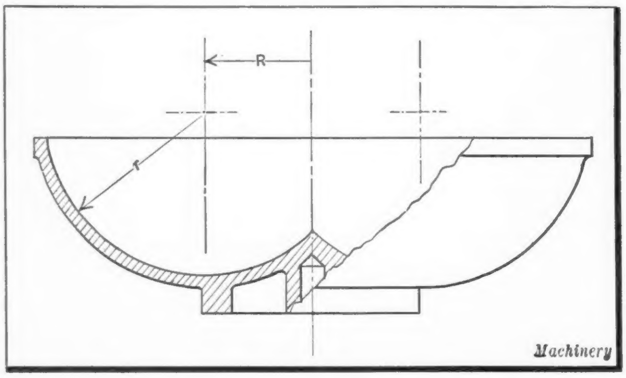


Fig. 1. Toroidal-shaped Bowl turned with Equipment shown in Fig. 2

Cutter." Instead of being hemispherical like an ordinary bowl, the surface to be finished had a toroidal shape, as shown in Fig. 1. As the quantity required was small, a simple hand-operated fixture such as shown in Fig. 2 was made. A disk A carrying a tool bit B was mounted on the carriage of the lathe in such a manner that it was free to turn about a pivot stud at its center C. The distance from C to the cutting edge of the bit was made equal to r, the minor radius of the torus, and stud C was set away from the center of the lathe a distance R equal to the radius of revolution of the torus.

It was intended that the disk be moved slowly by hand to feed the tool around the curve being turned, and the handle D was attached to the disk to facilitate this operation. Cross-feeding by hand is always a slow and delicate operation, however, and the operator found this job particularly tedious. After finishing a few of the bowls, he noticed an idle lathe next to his and an idea occurred to him. Securing a piece of flexible cable and a small pulley, he hitched the carriage of the second lathe to the feed-lever of his fixture as shown. All that was necessary then was to run both machines giving the carriage of the second lathe a slow feed. With this arrangement, the bowls were finished up smooth and true.

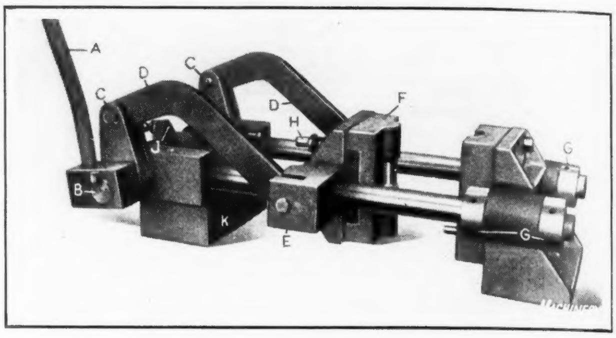
* * *

One of the laws of efficiency is to finish one thing completely before beginning another.

HAND-OPERATED DIE-CASTING MACHINE

By J. J. LINTON

The hand-operated die-casting machine shown in the accompanying illustration was designed as a compromise between the regular die-casting machine and the common cast-iron mold which is filled with babbitt from a ladle and then



Hand-operated Die-casting Machine

pried apart. The handle A is attached to a cross-shaft B on which two levers C are keyed. These levers are connected to bent links D which form double-acting toggles. The toggles operate a carriage E mounted on the guide rods that tie the ends of the machine together. One-half of the die F is attached to the carriage and the other half to one of the end-blocks of the machine. The lock-nuts G provide means for adjusting the dies so that they will be held firmly together when the toggle is on center.

After the casting is poured, the dies are opened wide by swinging the handle A 180 degrees to the left. This movement of lever A causes the dies to open and eject the casting from the die F. The ejection of the piece is effected by two spring plungers, one of which is shown at H. The movement of lever A causes this plunger to come in contact with the end-block K. The plungers are attached to a plate which lies in a recess at the back of the die. This plate, in turn, forces ejecting pins through the die so that they strip the casting from the latter member.

Ejecting pins can only be used to good advantage on a die member attached to the carriage. For this reason care should be taken to mount the half of the die to which the casting adheres, on the carriage. A stop J is provided on

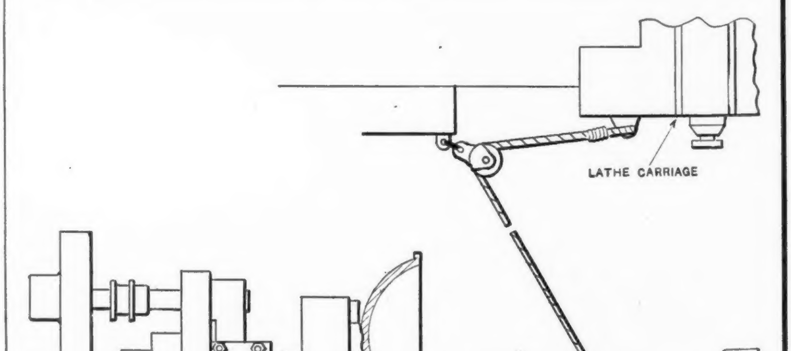


Fig. 2. Set-up for turning Toroidal-shaped Bowl

the cross-shaft to prevent the toggle from being moved too far past the center at either end of the stroke. It was found that dies made of machine steel gave much better results than those made of cast iron, there being less tendency for the work to stick in the steel dies.

The Manufacture of Wire Springs

By J. W. ROCKEFELLER, Jr., Manager Spring Division, John Chatillon & Sons, New York City

THE complete story of a wire spring would begin in the hematite and limonite deposits of the Lake Superior region or perhaps with the magnetite ores of Sweden. Its history from ingot to bloom and from bloom to rod would require chapters, at least, and the changes effected in the wire mill many pages more. Indeed, were an attempt made to cover all methods of wire spring manufacture from wire to finished spring the task would be almost hopeless, for in every plant engaged in the manufacture of wire springs there are certain practices peculiar to that plant.

The ability of certain plants to excel in the production of springs of various types is often the result of methods that have been adopted in those plants. Thus one manufacturer may specialize and excel in the production of a cheap machine spring, another in turning out valve springs, and a third in the production of springs for measuring instruments. In the manufacture of wire springs, however, there are certain methods that, due to their wide adoption, may be considered standard. It is the purpose of the paragraphs that follow to give a general description of such practices.

Purely manual methods of making springs are practised only in the machine shop and in the experimental departments of the larger spring factories. They have no place in the production of springs in quantities and will not be treated in this article. In general, we may divide wire springs into two classes—those that are coiled from spring tempered wire and given no subsequent heat-treatment (unless it be a slight draw, which partially removes the internal strains produced by cold working) and those that are coiled from annealed wire and afterward given a complete thermal treatment to impart the proper spring temper. The first method is obviously the cheaper, and hence is used for the majority of machine springs. The latter method, though more expensive, permits better control of the final state of the steel, and is used on many of the more expensive engine valve springs as well as on practically all springs used in measuring instruments. In both classes of springs the methods of manufacture with the exception of the heat-treatment, are almost identical, and the general statements made regarding spring manufacture may be taken as applying to one as well as to the other.

Method of Coiling Springs

The coiling of all springs made in quantities is accomplished either by a standard spring coiling machine, which may be adjusted to suit coil springs of various dimensions, or if the quantity of a particular type of spring desired warrants it by a special machine which coils, cuts, and hooks the spring in a single operation. Such a machine necessarily has a very limited range, and is found in automobile plants more often than in shops making springs for the trade in general.

Standard spring coiling machines may be classified as continuous coiling machines and coiling and cutting machines. In one machine of the latter type, designed for handling heavy wire, the length of the wire is controlled by the movement of a segment or by gears. The pitch may be automatically controlled so as to square the ends of the springs. This type of machine is used for extension springs as well as for compression springs. Conical and barrel shaped springs as well as springs of constant diameter and varying pitch also come within its scope. In the special machines, as in those for general manufacture, the operations consist of first straightening the wire by drawing it through a groove or rollers, and then coiling it by making it follow the course directed by external rollers or by a combination of external rollers and an internal mandrel. In the coiling operation, the spring wire is automatically tested for uniformity, since hard spots in the wire will be indicated by a bumpy or uneven surface on the coiled spring.

Hooking and Grinding the Ends

Extension springs are usually hooked at one or both ends. This is generally accomplished on a power or foot press in which one stroke ordinarily forms the hook. If the hook happens to be of a special design, it is formed by means of a hand jig, the construction of which depends upon the ingenuity of the machinist in charge of that particular phase of the work. Compression springs, in the majority of cases, have both ends squared and ground so the axis will coincide with the line along which the force is exerted.

The squaring of the ends is accomplished on the automatic coiling machine, and the grinding is done on a double-disk grinder. On such a grinder, two abrasive disks about 20 inches in diameter, rotating in the same direction, grind both ends of the spring simultaneously. The plane of rotation of one of the disks is fixed, while the other may be controlled by a hand-lever or a foot-pedal. A stop with micrometer adjustment limits the travel of the movable disk and fixes the distance within which the disks may be brought together, likewise determining the over-all length of the finished spring. While the ends are being ground, the springs are held in a rack of wood or metal. Various refinements of the double-disk grinder have been produced with the object of simplifying its operation and increasing production. Grinding the ends is generally the last operation performed upon compression springs, and whether the springs are coiled from tempered wire or heat-treated after coiling, is always accomplished with the spring in a hardened state, since the action of the grinding wheels upon the soft steel wire would have a tendency to distort the springs.

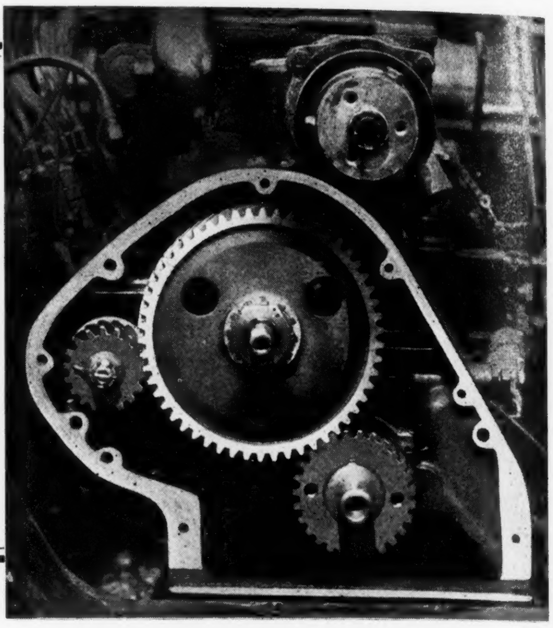
Factory Inspection of Springs

The method of inspecting finished springs at the factory depends largely upon the class of spring inspected as well as upon the magnitude of the tolerances allowed in the original specifications. The purchaser sometimes specifies that every spring shall be given a load deflection test before it leaves the factory, but ordinarily only a few springs from each lot are given such a test. Testing machines are used for compression and extension tests. For very small springs, simple testing machines are often improvised which speed up the testing operations considerably. Sometimes several springs from each lot will be subjected to a fatigue test of from ten thousand to a million compressions. In such tests every effort should be made to have the conditions of the test approximate, as nearly as possible, the actual application. The deflection should be the same and the frequency at which the stresses are imposed should be the same as under service conditions. The temperature is a factor that must not be neglected if the shop tests are expected to be a criterion of future performance.

No inspection or laboratory test can take the place of the ultimate test that springs receive under actual service. For this reason every manufacturer is vitally interested in the history of his springs after they leave the factory and desires to keep in close touch with their performance. As in the case of most commodities, cooperation between the manufacturer and the consumer of springs is the chief factor working for the advancement of their mutual interests.

Noisy Timing Gears

Causes and Remedies



Fundamental Causes of Noisy Gears, and Suggestions for Preventing Objectionable Noise without Resorting to Expensive Finishing Operations

By C. M. ALDRICH
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THE entire field of gear production is so vast that it would be impossible to cover more than a very small portion of it completely in an article of ordinary length. It is assumed, however, that the readers of MACHINERY are acquainted with the general design and common methods of manufacture of gears, and the following remarks will be confined exclusively to the causes and remedies of noises in hobbed helical gears. The fact that gears produced by the hobbing method have been chosen does not in any way imply that hobbing is the best method nor that it is the method most in need of improvement. The word "gear" or "gears," as used in this article, refers to the helical gears used for driving the camshaft and accessory shaft or shafts in an automobile engine.

The term "quiet gears" is in itself a misnomer, since gears, because of their shape and action, must cause sound. This sound, under certain conditions, can be made unobjectionable as will be shown. For want of a better term we will call those gears whose operation causes a sound that is not objectionable to the human ear "quiet gears." The action of gears in coming into and leaving mesh is not the mystery that it is popularly supposed to be. It is possible, by a little careful study, to find out exactly what happens when two gear teeth mesh. A method will be outlined as simply as possible, that has been applied with some success to determine exactly what happens in the action of gears to cause noise, and how these causes can be remedied.

In order to investigate gear troubles intelligently, it is necessary to go considerably deeper than the action of the gears themselves. Sound is the effect on the ear of air waves of a certain range of length and frequency. Sound may be roughly divided into two classifications—pleasant and unpleasant sounds or noises. Unpleasant sounds are those caused by a rapid and wide variation of either volume or pitch or both.

The simplest source of sound, or that source most easily analyzed, is the tuning fork by which a certain musical note is produced by setting a bar to vibrating. For the note lower C, the free bar makes 129 complete, back-and-forth vibrations in one second. Corresponding to each movement of the vibrating rod there is a movement of the air. As the bar moves to the right, the air immediately to the right is compressed. As the bar moves back to normal position the pressure on the adjacent air is released and is rarefied as the rod moves on to the left. In 1/129 of one second the air adjacent to the rod is compressed, changes back to normal, and is rarefied. This action is communicated to the surrounding air and forms a series of air waves which may be compared with the waves formed on the smooth surface of a pond when a pebble is tossed in. There is a certain fixed range of wave frequencies above which and below which these air waves have no effect on the human ear.

A perfectly smooth circular disk revolving in the atmosphere would produce no sound. A disk, the surface of which is not perfectly smooth, will produce a sustained sound, as the roughnesses on it alternately compress and release the adjacent air strata, the pitch of the sound depending upon the speed of the disk. A circular saw is a good example: As long as the speed of the disk is constant the sound is constant, but the sound increases as the speed increases and decreases as the speed decreases. If the disk, instead of running at a constant speed, were to accelerate uniformly through one-half revolution and decelerate through the other half, it would cause the sound to increase and decrease in pitch uniformly and regularly.

Now if we go still further and place a metallic plate in such a position that the roughnesses on the disk are rubbing over the flat surface of the plate, the vibrations which before were transmitted directly to the air are now causing similar vibrations in the plate which, in turn, transmits these vibrations to the atmosphere. On account of the increased area of the plate over that of the roughnesses of the disk, the volume of the vibrations is accordingly increased. The best known application of this principle is the motor-driven automobile horn.

Every individual gear drive has its own characteristics, so that it is impossible to lay down inflexible rules for obtaining the quiet operation of all gears. With this in mind, the author has confined this article to the methods by which objectionable noise has been overcome in automobile timing gears without employing expensive grinding, burnishing, or matching operations. By applying the successive phases of reasoning outlined, replacements in the final test have been reduced from 75 per cent to less than 10 per cent during a period of five months; at the same time the standard of quietness now required is much higher. At another plant where this system was tested under the direction of the author, the machine scrap was reduced from 15 per cent to less than 5 per cent, replacements in the final assembly from 12 per cent to less than 1 per cent, and production was increased 25 per cent without any additions being made to the equipment.

Application of Basic Principles to Gearing

One gear rotating alone at high speeds will produce a sound—very slight, it is true, but a sound nevertheless. Another gear meshed with the first one acts the same as the metallic plate just referred to. If these gears are revolving at a constant

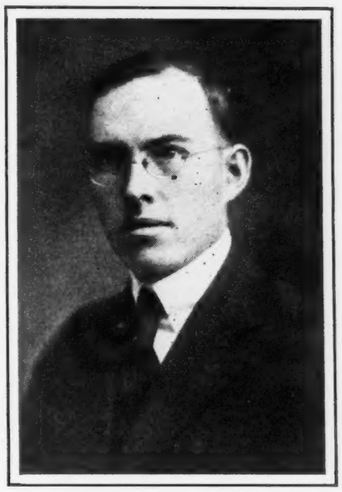
speed, the sound will be steady, sustained, and not objectionable. If one or both of the gears are eccentric, the sound produced will be similar to that caused by the acceleration and deceleration of the disk, as described previously. Any unevenness in spacing of the teeth in either or both gears will accentuate this action, and make the sound objectionable. This, as well as the roughness on the surface of the gear teeth, which will be taken up later, is the condition we have to combat in producing quiet gears.

A number of manufacturers have been more or less successful in producing quiet gears by adding operations that either remove the roughness on the surface of the teeth, correct the tooth spacing, or both. This calls for an unusual degree of accuracy in manufacture. It has been the object of my research to eliminate instead of adding operations, and to compensate for rather than attempt to decrease inaccuracies.

In order to cover thoroughly all possibilities of noise in gears, it is merely necessary to discover what, in the action of the gears, is setting up sound waves or vibrations. If we are to have absolutely silent gears, we must eliminate the cause of these vibrations, or failing in this, we may decrease the range of variation in volume and pitch, thus changing the noise to a sound that is not objectionable. Owing to the peculiar form of action between meshing gear teeth, any variations from the ideal may set up vibrations. With this clearly in mind, we may conclude that there are three major causes of noisy gears.

1. Inaccuracy in the gears.
2. Inaccuracy in other parts of the assembly.
3. Inaccuracy in tool manufacture.

Each one of these causes may be subdivided into a number of other causes. Any one or any combination of these causes will produce noisy gears. This noise will be amplified by certain other parts of the motor, as well as the chassis and body. We will now take up these causes in the order given, and analyze them to see where they might cause trouble and what can be done to remedy this trouble.



C. M. ALDRICH is a graduate of Lehigh University. After graduation, he spent three years learning the practical side of the gear manufacturing business, first as an operator of a battery of hobbing machines, and later as job-setter and production foreman of the gear department at the plant of the Chalmers Motor Co. For the past seven years he has been making an extensive study of the theory of gearing, three years of which were spent at the Studebaker Corporation in gear research work. Recently he became gear engineer of the Olds Motor Works at Lansing, Mich., where he is continuing his investigations of gear tooth action.

Inaccuracy in Gear Manufacture

In connection with gear manufacture, the following points will be considered in the order named: Condition of the equipment; carelessness in setting up the machine; and carelessness in operating the machine.

There are several types of machines now on the market for hobbing helical gears. The manufacturers of these machines are somewhat handicapped, owing to the fact that it is necessary to make each machine universal. That is, each machine must be so designed that it is possible to cut gears having a wide range of tooth numbers and helix angles. In order to obtain this universal action, it is necessary to have a transmission between the work-arbor and the hob-arbor that will provide for all the required changes. The machines now on the market use from sixteen to twenty-two gears to transmit motion from the work-arbor to the hob-arbor. If the shafts for these gears, or the gear faces, do not run true, such inaccuracies will cause the work-arbor to advance and retard in relation to the hob-arbor; but inaccuracy in the tooth spacing of the gears in the work- and hob-arbor transmission, has the most detrimental effect on the gears being cut. Any inaccuracies in tooth spacing will be transmitted and multiplied throughout the length of the gear train and will be reproduced, to a greater or lesser extent, in the gear being cut. The direct effect of such inaccuracies would be a waviness throughout the length of the tooth and an unevenness in tooth spacing.

Setting up a machine for gear-cutting consists in mounting the hob on the hob-arbor, selecting and mounting the change-gears, and placing the work-arbor and work in position. The most important points connected with this setting up operation are the mounting of the hob- and work-arbor, although any run-out or backlash in the change-gears will have an effect on the gear being cut.

The hob should be centered radially on the hob-arbor with extreme accuracy. The majority of the manufacturers of ground hobs grind the hubs at the same time that the teeth are form-ground. When the hob is put on the machine it should be indicated on both hubs. The extreme allowable limit of run-out on the hubs should be 0.0005 inch. Any eccentricity should occur on the same side at both ends of the hob; that is, the center line of the pitch cylinder should be parallel to the axis of rotation. In this case even if the eccentricity is excessive, there will be no wabbling motion, although this motion will be produced and will increase rapidly as the angle between these center lines increases.

An analysis of the action of a hob that is running out will show the necessity for extreme accuracy. A hob that is running eccentric presents one high tooth to the work with the teeth on each side in a circumferential direction, uniformly decreasing in height. When this high tooth is centered relative to the center of the tooth gash, it is cutting that portion of the gear tooth on each side of the pitch line, and is cutting the sides of the gash deeper than normal. The teeth on each side of the high one cut successively shallower, so that, if one convolution of the hob finishes one gash complete, the effect will be to widen the gash at the bottom of the working depth and narrow it at the top.

In actual practice, a number of hob teeth (varying inversely with the number of teeth in the gear to be cut) on each side of the working convolution, are cutting the sides of the gear tooth points. If these teeth successively increase in height, it is readily seen that the whole form of the tooth is altered, as well as the apparent obliquity. The reverse of this condition is caused by centering the low tooth relative to the center of the gash. Centering any of the other teeth will place the cut of the high tooth above the pitch circle on one side of the gash and below on the other side, causing a "leaning tooth" or a tooth with an apparent obliquity greater than normal on one side and less than normal on the other.

In spite of many authorities to the contrary, it is not necessary to center a hob longitudinally. A hob is absolutely self-centering unless it is running eccentric, in which case the correct tooth form cannot be produced. The only effect produced by centering a hob is to locate the various lengthwise tangential surfaces of which the gear tooth is formed, at equal distances from the point of the tooth on both sides. Since these minute surfaces are tangent to the gear tooth contour and their width depends upon the pitch of the gear and the number of gashes in the hob, their location has absolutely no relation to the form of the tooth.

Absolute neatness and cleanliness in the operation of a hobbing machine is of great importance. Any dirt or chips between the faces of the gears being cut will cause exactly the same conditions as misalignment of the gears in assembly. The gears being cut must be watched continually for running-out errors, both on the face and on the periphery.

Effect of Errors in Remainder of the Assembly

The care with which the remainder of the assembly is manufactured has as much bearing on the quiet operation of the gears as the manufacture of the gears themselves.

The important points to be watched vary so widely in different assemblies that it is possible only to generalize on their effect. In general, the conditions to be guarded against are variations in the center distances at which the gears are run, misalignment of the shafts, radial play in the bearings, and the general design of any assemblies that are being driven by the gears. Gears have always been the cause of so much of the objectionable noise in an automobile that they are often blamed for noises that are really caused by some assembly near them, or driven by them. It is really surprising how perfect an imitation of gear noise a rough bearing in a generator can give.

The importance of accuracy in center distances cannot be overestimated, as there is a positive limit to the variation in backlash at which gears will run quietly. It is possible to design gear teeth that will allow a tolerance of as much as 0.008 or 0.010 inch in center distance, but such gears must, of necessity, have a long involute flank and, as will be shown later, this is not the ideal form of tooth.

It is unnecessary to go into detail regarding the necessity of keeping the shafts parallel or of eliminating radial play in the bearings. Either of these conditions will cause misalignment of the gears, with a consequent increase and decrease in the relative angular positions during each revolution. As to the parts that are assembled with the gears, the points to watch in the assembly will vary widely with different designs. The important things to inspect are the alignment of the shafts, the end and radial play in the shafts, and the run-out on the face of the gears. No type of gear or form of gear tooth has yet been developed that will either compensate for or deaden the effect of the wide range of vibrations caused by running gears together at a varying angle to each other.

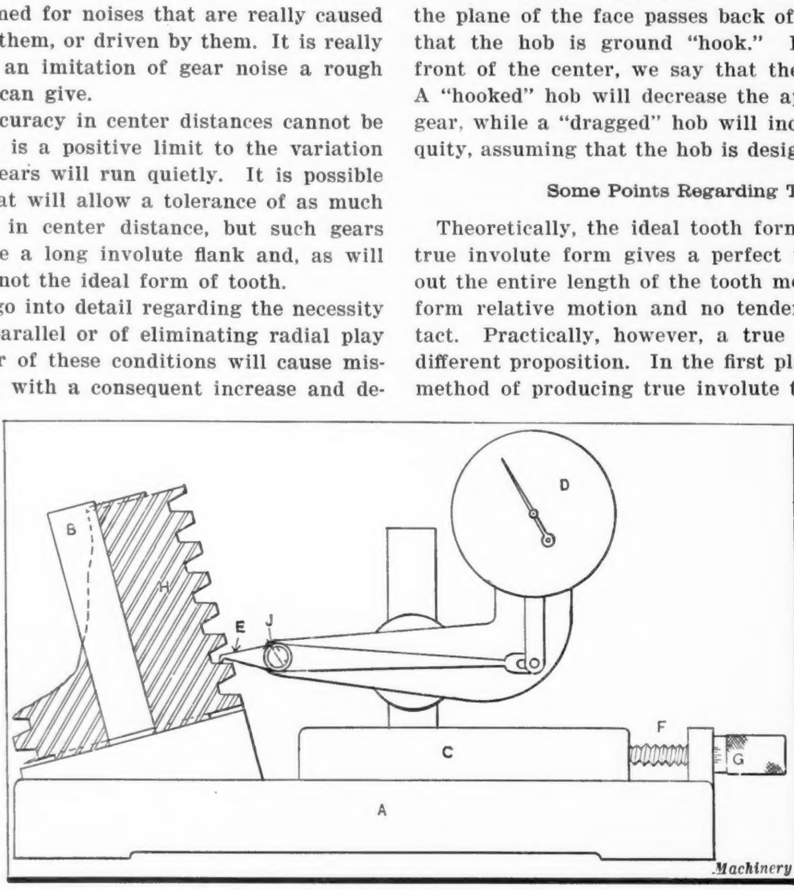


Fig. 1. Fixture for testing Accuracy of Hob Teeth

Effect of Hob Inaccuracies

It is the usual custom for the manufacturer to purchase his hobs from a firm that makes a specialty of that class of work. All hobs, however, should be subjected to very close inspection. There are two major defects in hobs which, although the maker may watch his manufacturing process very closely, are bound to creep in at times. These are variations in lead and variations in tooth form. The variations in lead will have exactly the same effects on the finished product as are caused by running the hob eccentric—that is, either a variation from normal in obliquity or a leaning tooth. The faults caused by variations in tooth form are too obvious to require any explanation.

In the writer's opinion, we have, in the past, blamed much of the trouble from other causes on the infinitesimal errors in commercial hobs, and by so doing, have forced the hob manufacturers to hold their product within almost impossible limits. Most of the manufacturers of ground commercial hobs will guarantee their product to be within 0.0002 inch of nominal size and shape in all dimensions which in any way affect the working of the hob. While an increase in these tolerances is not advocated, the writer claims that when the gear manufacturer succeeds in maintaining a limit of accuracy of ten times this tolerance in eccentricity, face run-out, machine set-up, and tooth spacing, it will be time enough to ask the hob manufacturer to hold his product to closer limits.

The sharpening of hobs is as delicate a process as their manufacture, and we can introduce almost exactly the same errors into hobs by carelessness in sharpening that we are so particular about in new hobs. Any variation in spacing the gashes in sharpening will have the same effect as the hob running out on the arbor or errors in lead in the hob itself. Most of the hobs now manufactured are designed to be ground radial; that is, the front faces of the teeth would, if extended, pass through the axial center of the hob. If the plane of the face passes back of the hob center, we say that the hob is ground "hook." If this plane passes in front of the center, we say that the hob is ground "drag." A "hooked" hob will decrease the apparent obliquity of the gear, while a "dragged" hob will increase the apparent obliquity, assuming that the hob is designed for radial grinding.

Some Points Regarding Tooth Forms

Theoretically, the ideal tooth form is a true involute. A true involute form gives a perfect rolling contact throughout the entire length of the tooth mesh, with absolutely uniform relative motion and no tendency toward sliding contact. Practically, however, a true involute is an entirely different proposition. In the first place, the only practicable method of producing true involute tooth faces is by rolling the gear blank in proper relation to a cutter representing a rack or its equivalent. In the writer's opinion, the hobbing method of cutting gears more nearly approaches rolling against a rack than any other method. However, with this method there are twelve distinct cuts required to finish each side of each tooth form, assuming that a hob having twelve flutes or gashes is being used. This produces a series of extremely minute "flats," the intersections of which form projections above the true involute curve. The result is microscopic serrations running parallel to the axis of the gear. Since a true involute is in contact throughout the entire length of the tooth, any error in tooth spacing will cause it to tend to dig into the flank of the mating tooth as it comes into engagement. This error in curvature will also prevent true rolling contact and give a sliding contact for a large portion of the tooth length.

C. H. Logue suggests possible correction of this tendency by increasing the outside diameter of the smaller gear and correspondingly decreasing the diameter of the larger gear, sinking the hob to the same depth as normal, and cutting the same number of teeth as normal. The greater the change in diameter, the more the arc of action is thrown into the arc of recession and taken out of the arc of approach.

The sliding contact through the arc of approach may be likened to pushing a sharpened stick against the grain of a rough board. The point of the stick will catch on all the irregularities on the surface of the board, while the action of the arc of recession is just the opposite, or like dragging the sharpened stick in the direction of the grain. The point of the stick will rise and ride over the irregularities in the surface, where before it caught on them. This correction resulting from the proposed diameter changes, will undoubtedly decrease the noise of the gears, but the wearing quality will decrease in direct proportion to the increase in the arc of recession.

The only other standard form of gear tooth at present is the cycloidal form. This system theoretically gives true rolling contact, but the slightest variation in center distance destroys the rolling contact to a greater extent than propor-

tional to the change in center distance. With the elimination of rolling contact also comes an excessive variation in relative angular velocity. The author contends, therefore, that there are serious drawbacks to both the involute and cycloidal tooth forms, which, if the tooth form is to be successful necessitates holding work to practically an impossible degree of accuracy.

If we are to produce quiet gears on a quantity basis, we must develop a new tooth form that will somewhat compensate for other inaccuracies. It is the writer's opinion, based upon practical tests, that the ideal tooth form and the one that will eventually came into general use, is a combination of the two standard tooth forms that are now in use. This tooth form will have a cycloidal root and point, with a short length of involute flank between. The cycloidal portion will insure a true rolling contact, to some extent, while the involute portion will compensate for the variations in center distance. In designing such a tooth form, it would be well to keep in mind the fact that while the actual bearing portion of the tooth will, of necessity, be narrow (the narrower the better), the surface of the flank on each side of this bearing should fall away from the involute section of the bearing very gradually so as to rapidly increase the width of the bearing as the face of the tooth wears.

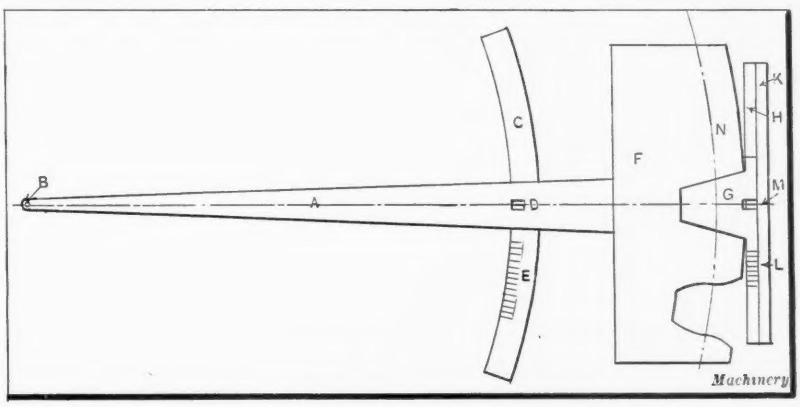


Fig. 2. Device used for laying out Tooth Curves

The first step in developing a new tooth form and, in the writer's opinion, the most important step, is the development of an accurate method of measuring present tooth forms. An excellent fixture for this purpose is shown in Fig. 1. It consists of a base A in which is pressed a pin B, and on which a slide C is mounted, carrying a dial indicator D in such a position that the point of the indicator E moves on a line that intersects the center of the pin B when the slide is actuated. A lead-screw F provided with a micrometer head G is provided to move the slide.

The hob H to be tested is mounted on pin B, which is set at such an angle that the contour of the hob tooth is parallel with the base of the fixture. As the point of the indicator is moved in over the surface of the hob tooth, any variation from a straight line will be measured directly by the indicator. This indicator may be arranged, by means of a lever pivoted at J, to give whatever multiplication in the measurement is desired. With this fixture, the exact form of the hob tooth can be determined by plotting the measurements taken to any enlarged scale and joining the points so plotted by straight lines.

The next instrument necessary for the study of tooth forms has been called a "graphic hobbing machine." This consists of a flat-topped table (see Fig. 2) which is covered with a sheet of 16-gage metal. A is an arm of the same metal, which is pivoted at B and has a blank segment F at the other end. Protractor segment C has its center at B. This protractor is graduated to 1/12 of the circular pitch of the gear to be studied. Straightedge K is mounted at right angles to a line through B, and is superimposed upon a graduated scale H. The graduations of H, as shown at L, are 1/12 of the lead of the hob. Twenty times actual size has been found to be a good size to make this apparatus; that is, the graduations at both E and L are twenty times normal, and the distance from B to the pitch circle is twenty times the pitch radius of the gear. There is a square hole D in the arm A with a hair line across it. G is a hob tooth templet that slides along straightedge K and has a hole M similar to hole D through which to read the graduations.

The method of operating this apparatus is to place the arm and the hob tooth both on the center graduation and scribe around the hob tooth on the blank F; then move both hob and arm, one graduation to either side of the center and scribe around the hob tooth in each of these positions, and repeat this moving one graduation at a time until the entire outline of the hob tooth lies inside the area previously scribed. Move the arm A until the hair line at D matches with the twelfth graduation either side of the center. Place the hair line M on the center graduation and repeat the previous operation. Then, starting with hair line D twelve graduations the other side of the center, and with M on the center, repeat again.

This gives three tooth spaces hobbed out in identically the same manner as on a commercial hobbing machine, the lines scribed around the hob temple corresponding with successive cuts of the hob teeth in actual practice. If the hob tooth profile has been made accurately and the successive operations in the graphic hobbing have been carefully done, we have the outline, twenty times enlarged, of three gear teeth of exactly the same shape as would be produced on a hobbing machine with a hob of the same tooth form. If we now file out these tooth spaces, being very careful to file just to the inner line, we have a segment of the periphery of a gear. The effects on tooth form caused by an eccentric hob may be studied by replacing straightedge K with a sine curve having a lead equal to the lead of the hob and a height equal to the indicated run-out to be studied.

After laying out the tooth forms on one segment, substitute a new blank for F, change arm A and protractor C to correspond with the size of the gear that runs with the one previously developed, and by following the same process, lay out three teeth on the new blank. By pivoting the point B on each of the two arms a distance apart equal to twenty times the center distance at which the gears run, these two segments can be rolled together, and the exact action that takes place as the teeth come into and leave mesh can be studied very accurately.

The writer's method of producing the hob tooth templet is to clamp the templet blank in a vise with the base of the blank at the angle of obliquity to a surface plate; then check the edge of the templet with a dial indicator by sliding it on the surface plate, filing and stoning the edge until the coordinates of the contour curve correspond to the coordinates of the contour curve of the hob tooth to be duplicated. It is desirable to hold this form to within 0.0005 inch of nominal size.

Checking Relative Uniformity of Motion and Compensating for Variations in Spacing

The next instrument needed is some device for checking the relative uniformity of motion between the gear templets through one tooth mesh. The fixture shown in Fig. 3 has been used rather successfully for this purpose. There are two segments of circles A and B, which are of the same radii as the pitch circles of the gear templets on which they are placed. These segments are pinned to the gear templets so that the curved edges coincide with the pitch circles of the gear templets. Thin steel ribbons are fastened to the corners of these segments at C and D. The other ends of these ribbons are fastened to blocks F and E; F slides on ways on E. A dial indicator H, mounted on F with its point resting against a post G in E, measures accurately the relative position of the two blocks. If the gears are pulled

through one tooth mesh, by moving the block along the common tangent, the relative position of the blocks will be the same as the relative angular position of a point on each of the pitch circles of the gear templets.

Since commercial gear-manufacturing equipment cannot be expected to give absolutely uniform tooth spacing, it is advisable to bear in mind while developing new tooth forms, that this variation in tooth spacing must be compensated for. If we have absolutely uniform relative angular velocity throughout one tooth mesh, then a variation in tooth spacing will cause a sudden jump at the end of the tooth mesh. However, if we determine how much variation in tooth spacing we must compensate for, and then design the gear tooth so that it advances and retards gradually that amount during one mesh, instead of having a sudden jump at the end of the tooth mesh, the variation will occur gradually.

One method of determining how much variation in tooth spacing to compensate for is to cut two gears *A* and *B* (see Fig. 4) on the same arbor; then reverse gear *B* so that side *D* is next to the side *F* on gear *A*; next index with a positive stop between the teeth of gear *A* and check with an indicator on the teeth of gear *B*. Any errors in the tooth spacing of the gears will be multiplied, and in designing the tooth form it will be necessary to compensate for only one-half of the apparent errors.

It is evident from the foregoing that timing gear noises can be traced directly to one or both of two conditions. First, there may be a series of vibrations caused by sliding or rubbing action between two serrated surfaces; second, there may be a series of vibrations set up by the acceleration and retardation of the mating gears, caused by inaccuracy in tooth spacing. The volume of the vibrations caused by the rubbing between two serrated surfaces will remain fairly constant, while the frequency will decrease and increase as the sliding contact approaches and recedes from the rolling contact. The peripheral speed of the gears in the timing gear train is the same; hence the tooth serrations engage each other at the same speed.

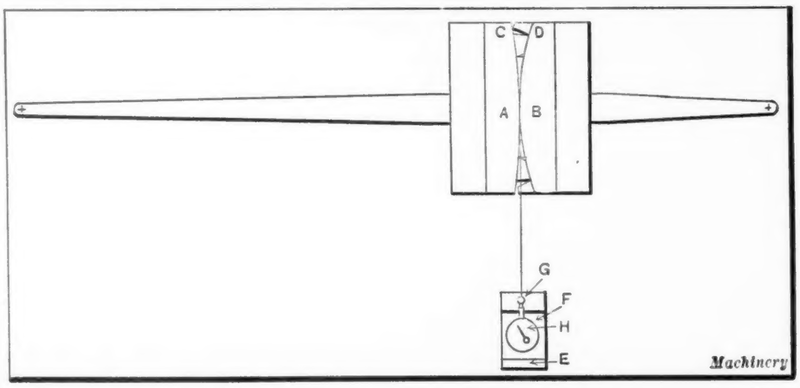


Fig. 3. Apparatus used in Experimental Work for testing the Relative Motion of Meshing Templets representing Gears

On the other hand, the frequency of the vibrations caused by irregular tooth spacing in any one mesh will be fairly constant, while the volume will vary with the variation in spacing. As it is most unlikely that the variations of tooth spacing in all of the timing gears are the same, we have separate sets of vibrations, of a different and, in some cases, of a varying volume and frequency in each of several places.

Pressure Angle and Size of Tooth

The angle of obliquity of two mating gears has a direct relation to the rolling contact between the teeth of those gears. The smaller the angle, the less the rolling contact, but the more gradual and quieter the engagement, within certain limits. Another feature that must be watched in gear design, and that is a direct function of the pressure angle, is the under-cut caused by the point of the hob. This under-cut increases in somewhat more than direct proportion to the decrease of obliquity. A safe limit for the angle of obliquity is 14½ degrees, although 13½ and even 12½ degrees have been used with fair success. If the angle is below 14½ degrees, the under-cut, and consequent weakening of the teeth, increases entirely too rapidly for safe practice.

On any helical gears the sine of the angle of actual obliquity increases in direct proportion with the secant of the helix angle. If the angle of helix is increased to about 45 degrees, the actual obliquity should be slightly increased. An actual obliquity of 14½ degrees on a 45-degree helix angle gives a normal obliquity of approximately 10 degrees. If we cut the normal obliquity below this, we are thinning the tooth to a point where the increased angle will not take care of the consequent weakening.

A decrease in the size of the tooth will decrease the amount of variation in angular velocity. This decrease bears a direct proportion to the volume of the vibrations that are set up by the acceleration and retardation of the mating gears. Since sound is a series of vibrations and the volume of sound is directly proportional to the length of the vibration, it is reasonable to assume that a decrease in the size of the tooth will decrease the volume of sound, all other inaccuracies being equal. Bearing a direct relation to this condition, is the fact that a decrease in the size of the tooth carries a corresponding increase in the number of teeth, increasing the frequency of the vibrations, and hence raising the pitch. With this in mind, it becomes a question of preference between a low, high-pitched or a loud, low-toned sound.

Helix Angle, Axial Thrust, and Number of Teeth

Where quietness of operation is the only requirement, it may be attained by acquiring a sufficient number of contacts at the pitch point and limiting the conjugate action on the plane of rotation to a minimum, so that possible errors in tooth formation can have no material effect on the angular velocity ratio. In designing helical gears from this point of view, we are restricted first, by the percentage of axial thrust that may be allowed or carried, and the tooth area and curvature necessary to maintain desirable wearing qualities. Regarding the latter point, there is, of course, a reduced increment load due to the smooth action obtained by the higher helix angles, so wearing quality is not reduced in direct proportion for that reason.

To generalize, smooth operation is produced by a large number of pitch-point contacts, obtained by a reduction in normal circular pitch and by high angles of helix, with short angles of action, and an obliquity just sufficient to provide effective addenda for the angles of action employed. The extent to which this specification may be approached depends upon the wearing quality necessary. The axial thrust is the tangential tooth pressure *times* the tangent of the angle of helix; the percentage of thrust is, for all practical purposes, the tangent of the angle of helix. This is the first point to be settled, as the highest possible angle of helix should be used.

Consider a pair of single-thread worms, right- and left-hand, operating on parallel shafts. Quietness of operation would be assured, but the thrust would be, say ten or twelve times the tangential tooth pressure, and the entire length of action for each pitch point contact would be little more than the depth of the engaged portion of the tooth. These worms might be used for only the very lightest service, and they merely illustrate the extreme of helical gear design. Making these worms each right- and left-hand, in herring-bone formation, will remove all axial thrust but will make no change in wearing quality for a given face width.

For a given normal circular (or diametral) pitch, wearing quality will increase with the number of teeth, but so will the noise of operation. Aside from any consideration of the increment tooth pressure, occasioned by irregularities in pitch-line velocity, both wearing quality and noise of operation reach a maximum when the number of teeth has

been increased to a point where the normal circular pitch and the circular pitch are equal. The cosine of the angle of helix is the ratio of the normal circular pitch and the circular pitch. In case a desirable angle of helix results in an excessive thrust, the possibilities of double helical, or herringbone gears, might be considered provided the cost of such gears is not a barrier to their use. By this we may open up a field which may not be entered by the plain helical gear.

Herringbone gears may be assembled in place of the present helical gears with no particular difficulty. An important point regarding high-angle helical or herringbone gears is that for the same amount of wear on the normal tooth section, the resulting change in the position of the teeth in the plane of rotation (angular position) increases directly as the tangent of the angle of helix. For timing gears this is, of course, a most important consideration and must influence the selection of this angle.

Path Followed by Vibrations

We have seen how a series of minute vibrations is started from timing gears, how these vibrations themselves can be more or less controlled, and how, under present conditions, it is practically impossible to eliminate them. Now let us follow these vibrations and see what happens to them after their inception at the point of contact between two gears. In general, the vibrations started at the gears will follow the path of least resistance. The steel shafts, being of a "live" metal, will carry these vibrations without loss. If the shafts touch at any point a large flat plate, such as the gear cover, the vibrations will be amplified proportionally. If, in turn, the plate touches, or is fastened to, another path of "live" metal, this path will carry the amplified sounds without loss to any vibratory field that happens to be fastened to this path, and the sounds are again amplified.

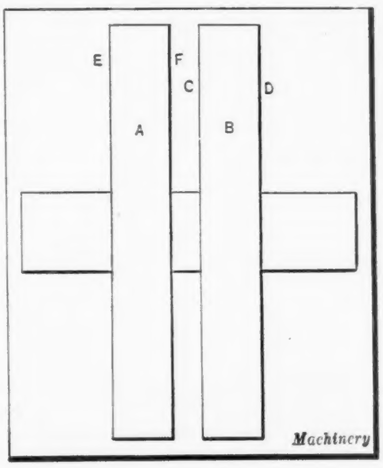


Fig. 4. Diagram illustrating Method of checking Tooth Spacing

Each different car must necessarily be studied by itself, but if precautions are taken to dampen the sound waves by insulating them as soon as possible after their inception, and then to dampen those that filter through before they reach an efficient amplifier, it will greatly assist in quieting the assembly. Under present conditions, the manufacturer who would produce quiet gears without adding a number of expensive grinding, burnishing, and matching operations must make a careful study of the conditions governing the accuracy of manufacture and of the requirements of his individual job. If the inaccuracies are within ordinary commercial limits and there is no excessive amplification in the design, a tooth form can be developed that will insure quiet gears.

* * *

POINTERS ON THREAD ROLLING

By A. R. VAN TASSELL
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Selection of the proper material is an important factor in rolling threads. Excellent results are obtained when threads are rolled on brass stock, but this is an expensive material. Operations such as turning, heading, upsetting, etc., as well as the thread rolling operation, must sometimes be considered when selecting the stock for parts made from steel.

Soft steel containing from about 0.07 to 0.12 per cent carbon is suitable for thread rolling. Iron of ordinary quality is not adapted for the thread rolling process because of its fibrous structure, which makes it likely to split or fracture as a result of the pressure caused by the thread rolling operation. One company recommends the use of "liquor"-finish soft steel wire, claiming that this material will give the best results with the minimum of wear on both the header and the thread rolling dies. If the "liquor"-finished wire cannot be obtained, a good grade of annealed and cleaned wire may be employed. Another concern recommends the use of wire of the following composition: Carbon, 0.08 to 0.12 per cent; manganese, 0.35 to 0.45 per cent; phosphorus, 0.03 to 0.04 per cent; and sulphur, 0.03 to 0.04 per cent. This material has a tensile strength of about 56,000 pounds per square inch. However, material of these specifications cannot be purchased in small quantities; some mills will accept orders of 10,000 pounds.

Bright basic wire is one of the best and cheapest materials obtainable, and is suitable both for heading and cold roll threading. This material is hard enough to permit a slot to be cut after the heading operation by means of a slotting machine. The bright basic wire can be obtained from local shops in small quantities and from the mill in lots of 2000 pounds or more. It is generally best to obtain it from the mill, as the quality is likely to be more uniform.

The wire mills will accept a tolerance specification of plus or minus 0.002 inch on the diameter. It is particularly important that this tolerance be maintained on stock used for long screws of small diameter. On screws of short length the material will flow, and if the wire is over-size little trouble will be experienced, but in the case of screws having a length greater than ten times their diameter, the material will be confined, and "burning" will take place, if the tolerance is greater than that specified. If the wire is slightly under size, the rolled threads will have a very ragged appearance due to the fact that the crest is not fully formed. On screws under the 10-24 size, a tolerance of plus or minus 0.001 inch must be adhered to in order to insure good results. The diameter or size of wire to use may be calculated from the formula:

$$D = B - \frac{F}{8}$$

in which

D = diameter of blank;
B = pitch diameter of screw; and
F = depth of U. S. standard thread.

This formula is intended for use when the screw threads are rolled on bright basic wire.

The matter of lubrication must be well taken care of if maximum results are to be obtained from the dies. Incidentally, it may be mentioned that the expense for resharpening thread rolling dies is nearly as great as the cost of new dies. Practically the only salvage from old dies is the steel, and even this is not desirable, as it must be annealed in order to remove the old threads, after which it must be machined, rehardened, and drawn. It is, of course, undesirable to employ steel that has been previously hardened for tools of this kind. The material, the dies, and the method of handling the work must be taken into consideration in selecting the lubricant. Soluble compounds can be used when the operator's hands do not come in contact with the compound, but on small screws it is practically impossible for the operator to prevent the compound from causing sore hands. Where hopper feeds are used, a soluble compound can be employed to advantage. For hand feeds, a good grade of mineral lard oil should be employed.

Many different types of feeding devices are in use, each being satisfactory under certain conditions, but the average manufacturer will find that the added expense of a hopper feed is not warranted. It is possible to roll the threads on from 2000 to 3000 pieces per hour when the work is fed by hand. Care must be taken to see that feed-fingers hold the work square with the machine when it is fed into the dies and that it is held firmly until engaged by the moving member of the die. Finger ejectors are not necessary for ordinary work, particularly if a 45-degree type of thread rolling machine is employed.

Rubber Belting

Data and Formulas Required in Designing Rubber-belt Transmissions

By GUSTAVE A. FRENKEL

RUBBER belts as a medium for the transmission of power are subjected to the same laws as leather belts or any other elastic band wound around a circular revolving body. Rubber belts generally are made up of 28-, 32-, and 36-ounce duck, and their ultimate tensile strength varies from 900 to 1500 pounds per square inch according to the fabric used. The higher frictional resistance of rubber belting is offset by the heavier weight (0.0478 pound per cubic inch, as against 0.038 pound per cubic inch for leather belts) which results in centrifugal force having a greater effect.

Owing to the nature of a rubber belt (which is made up of plies) it is advisable to avoid extremely small pulleys whenever possible. The number of plies and the width of belt bear a certain relation to each other, and in order to have a well proportioned belt, the minimum number of plies given in Table 1 should be used whenever practicable.

TABLE 1. NUMBER OF PLIES IN RUBBER BELTING FOR DIFFERENT WIDTHS

Width of Belt, Inches	Minimum Number of Plies	Maximum Number of Plies	Width of Belt, Inches	Minimum Number of Plies	Maximum Number of Plies
2	2	3	18	5	6
3	3	4	20	6	7
4	3	5	22	6	7
5	4	5	24	6	7
6	4	5	26	7	8
8	4	6	30	7	8
10	4	6	36	8	10
12	4	6	42	8	10
14	5	6	48	8	10
16	5	6	54	10	12

Machinery

Working stress and pulley diameter are closely related, and in determining the minimum size of pulley for a rubber belt of a certain number of plies, the following formula can be used:

$$D = \frac{\sqrt[3]{S} \times N}{2.4} \qquad (1)$$

or

$$N = \frac{D \times 2.4}{\sqrt[3]{S}} \qquad (2)$$

where D = minimum diameter of pulley, in inches;
N = maximum number of plies; and
S = total stress of belt per square inch, in pounds.

The total stress or working stress S per square inch of belt was found to be 220 pounds for belts made of 28-ounce duck; 237 pounds for belts of 32-ounce duck; and 252 pounds for belts of 36-ounce duck. With these stresses, the highest efficiency of a rubber belt is attained, which means that the highest effective pull is exerted with the least initial tension, or the tension in the belt when at rest. If the pulley diameter is larger than 3 feet, the foregoing values for working stresses can be increased 20 per cent.

Owing to the greater effect of centrifugal force, the velocity of a rubber belt is limited, and varies according to the cotton fabric used. The following are the most effective speeds for different cotton fabrics: 3000 feet per minute for belts made of 28-ounce duck; 2700 feet per minute for belts made of 32-ounce duck; and 2400 feet per minute for belts made of 36-ounce duck. These velocities cannot be exceeded without decreasing the effective pull. The limiting velocities at which the effective pull of a rubber belt equals the working stress minus the centrifugal force are as follows: 3800 feet per minute for belts made of 28-ounce duck; 3500 feet per minute for belts made of 32-ounce duck; and 3200 feet per minute for belts made of 36-ounce duck. At these velocities the coefficient of friction reaches its highest value, and nothing can be gained by further increase, as the power-transmitting capacity will be reduced rapidly.

The coefficients of friction of rubber belts on iron pulleys are given in Table 2, and the values of effective pull p_1 per

TABLE 2. COEFFICIENTS OF FRICTION FOR RUBBER BELTS ON IRON PULLEYS

Velocity, Feet per Minute	28-ounce Duck	32-ounce Duck	36-ounce Duck	Velocity, Feet per Minute	28-ounce Duck	32-ounce Duck	36-ounce Duck	Velocity, Feet per Minute	28-ounce Duck	32-ounce Duck	36-ounce Duck
100	0.118	0.150	0.178	2600	0.493	0.575	0.675	5100	0.451	0.368	0.289
200	0.135	0.165	0.193	2700	0.515	0.600	0.710	5200	0.432	0.341	0.258
300	0.147	0.181	0.209	2800	0.538	0.639	0.765	5300	0.408	0.321	0.235
400	0.163	0.195	0.225	2900	0.567	0.668	0.840	5400	0.399	0.296	0.221
500	0.177	0.209	0.239	3000	0.600	0.715	0.953	5500	0.381	0.283	0.200
600	0.190	0.224	0.254	3100	0.625	0.793	1.130	5600	0.349	0.260	0.159
700	0.204	0.237	0.270	3200	0.660	0.877	1.340	5700	0.330	0.243	0.135
800	0.219	0.252	0.285	3300	0.713	0.970	1.080	5800	0.297	0.227	0.103
900	0.231	0.267	0.301	3400	0.769	1.230	0.920	5900	0.286	0.204	0.084
1000	0.243	0.280	0.315	3500	0.812	1.371	0.846	6000	0.280	0.172	0.060
1100	0.255	0.293	0.329	3600	0.977	1.065	0.758	6100	0.249	0.153	0.016
1200	0.270	0.306	0.348	3700	1.216	0.910	0.703	6200	0.220	0.131	0.014
1300	0.285	0.317	0.365	3800	1.460	0.840	0.653	6300	0.204	0.127	0.005
1400	0.297	0.334	0.379	3900	1.073	0.756	0.610	6400	0.171	0.115	0.002
1500	0.314	0.350	0.394	4000	0.987	0.725	0.588	6500	0.156	0.101	0.001
1600	0.325	0.368	0.415	4100	0.836	0.670	0.535	6600	0.114	0.084	0
1700	0.338	0.382	0.429	4200	0.768	0.627	0.512	6700	0.099	0.032	.....
1800	0.354	0.401	0.450	4300	0.714	0.582	0.478	6800	0.069	0.013	.....
1900	0.369	0.417	0.468	4400	0.658	0.557	0.463	6900	0.056	0	.....
2000	0.383	0.432	0.493	4500	0.652	0.524	0.442	7000	0.045	.....	.....
2100	0.405	0.457	0.514	4600	0.600	0.490	0.406	7100	0.012	.....	.....
2200	0.419	0.477	0.545	4700	0.556	0.463	0.378	7200	0.009	.....	.....
2300	0.435	0.499	0.570	4800	0.531	0.433	0.363	7300	0	.....	.....
2400	0.454	0.521	0.600	4900	0.510	0.410	0.328	.....	.....	.....	.....
2500	0.470	0.542	0.632	5000	0.491	0.406	0.313	.....	.....	.....	.....

Machinery

ply and inch of width for rubber belts are given in Table 3. Rubber belts are recommended where drives are exposed to dampness, acid fumes, etc., but should be avoided wherever a belt is subjected to steam or heat.

Formulas for Rubber Belt Calculations

In determining the size of a rubber belt, the total turning force or tangential force P has to be calculated first by using the following equation, which was given as Equation 9 in the article on "Short-center Belt Drives" published in July MACHINERY.

$$P = \frac{H \times 33{,}000}{V}$$

$$f = \frac{P}{p_1 \times 16} \quad (3)$$

The value of p_1 is to be taken from Table 3.

The number of plies required is determined by Equation (2), as follows:

$$N = \frac{D \times 2.4}{\sqrt[3]{S}}$$

in which

D = diameter of smallest pulley; and
S = 220 pounds for 28-ounce duck;
237 pounds for 32-ounce duck; and
252 pounds for 36-ounce duck.

TABLE 3. EFFECTIVE PULL (p_1) PER PLY AND INCH OF WIDTH FOR RUBBER BELTS, POUNDS

Velocity, Feet per Minute	Arc of Belt Contact, Degrees												
	160	170	180	190	200	210	220	230	240	250	260	270	280
	28-ounce Duck												
100	3.86	4.06	4.25	4.46	4.65	4.82	5.01	5.19	5.36	5.53	5.70	5.86	6.02
500	5.34	5.58	5.83	6.02	6.33	6.55	6.72	6.91	7.20	7.38	7.57	7.67	7.90
1000	6.65	7.10	7.21	7.47	7.73	8.06	8.20	8.41	8.60	8.82	9.00	9.20	9.37
1500	7.70	8.00	8.20	8.53	8.79	9.04	9.24	9.47	9.65	9.85	10.03	10.18	10.32
2000	8.24	8.61	8.87	9.15	9.40	9.57	9.78	9.96	10.12	10.30	10.45	10.59	10.71
2500	8.86	9.11	9.33	9.56	9.78	9.94	10.12	10.27	10.41	10.55	10.65	10.78	10.88
3000	9.25	9.46	9.64	9.83	9.97	10.09	10.22	10.35	10.45	10.52	10.60	10.69	10.74
3500	9.46	9.58	9.67	9.78	9.89	9.95	10.03	10.08	10.12	10.15	10.21	10.25	10.28
4000	8.90	9.00	9.07	9.15	9.20	9.24	9.30	9.32	9.35	9.37	9.39	9.42	9.44
4500	7.02	7.15	7.28	7.40	7.50	7.58	7.69	7.76	7.82	7.88	7.93	7.97	8.08
5000	5.12	5.35	5.47	5.60	5.72	5.82	5.91	6.00	6.08	6.15	6.22	6.28	6.31
	32-ounce Duck												
100	5.08	5.33	5.58	5.84	6.07	6.31	6.52	6.74	6.94	7.13	7.35	7.55	7.73
500	6.51	6.80	7.06	7.35	7.63	7.88	8.13	8.38	8.59	8.82	9.03	9.24	9.41
1000	7.89	8.22	8.50	8.80	9.07	9.35	9.57	9.82	10.02	10.25	10.43	10.65	10.80
1500	8.84	9.13	9.45	9.75	10.00	10.22	10.48	10.70	10.91	11.09	11.28	11.43	11.60
2000	9.55	9.81	10.10	10.35	10.59	10.80	11.00	11.21	11.38	11.53	11.69	11.84	11.93
2500	10.03	10.32	10.51	10.79	10.96	11.11	11.29	11.47	11.56	11.68	11.81	11.90	11.99
3000	10.40	10.60	10.78	10.93	11.06	11.17	11.25	11.38	11.47	11.52	11.58	11.61	11.68
3500	10.77	10.84	10.88	10.91	10.94	10.96	10.97	10.98	10.99	11.00	11.01	11.02	11.03
4000	8.60	8.79	8.90	9.04	9.13	9.24	9.30	9.37	9.43	9.48	9.54	9.58	9.63
4500	6.60	6.77	6.92	7.07	7.21	7.34	7.49	7.56	7.64	7.72	7.79	7.87	7.92
5000	4.83	4.99	5.13	5.27	5.40	5.52	5.61	5.72	5.82	5.92	5.99	6.07	6.15
	36-ounce Duck												
100	6.16	6.47	6.74	7.03	7.30	7.54	7.78	8.05	8.30	8.50	8.70	8.94	9.13
500	7.63	7.97	8.28	8.60	8.86	9.15	9.42	9.70	9.91	10.15	10.38	10.58	10.79
1000	8.79	8.98	9.44	9.76	10.03	10.30	10.56	10.85	11.04	11.28	11.50	11.69	11.88
1500	9.98	10.32	10.63	10.92	11.19	11.44	11.69	11.90	12.10	12.27	12.40	12.61	12.80
2000	10.70	11.06	11.31	11.54	11.78	11.98	12.19	12.37	12.50	12.69	12.80	12.91	13.06
2500	11.23	11.50	11.70	11.88	12.06	12.19	12.34	12.46	12.55	12.70	12.78	12.85	12.90
3000	11.70	11.82	11.94	12.03	12.11	12.18	12.24	12.30	12.33	12.38	12.41	12.45	12.48
3500	10.33	10.48	10.61	10.72	10.81	10.90	10.98	11.02	11.10	11.14	11.18	11.21	11.25
4000	8.15	8.36	8.52	8.66	8.82	8.95	9.05	9.17	9.24	9.32	9.40	9.47	9.54
4500	6.10	6.29	6.47	6.63	6.78	6.90	7.03	7.16	7.23	7.35	7.44	7.54	7.68
5000	4.03	4.18	4.33	4.48	4.62	4.72	4.85	4.96	5.05	5.16	5.25	5.34	5.41

Machinery

The notation in this and in the following formulas is as follows:

P = total turning or tangential force exerted by the entire width of the belt = $S_n - S_o$, in pounds;
H = horsepower;
V = velocity of belt, in feet per minute;
f = cross-sectional area of belt, in square inches;
p_1 = turning force transmitted per ply and inch of width of fabric belts, in pounds;
N = number of plies of fabric belts;
W = width of belt, in inches;
S_n = total tension in running belt on tight side, in pounds; and
S_o = total tension in running belt on slack side, in pounds.

The cross-sectional area of the belt is found by the formula:

The width of the rubber belt is next calculated from the following equation:

$$W = \frac{f \times 16}{N} = \frac{P}{p_1 \times N} \quad (4)$$

The total stress in the tight strand is found as follows:

$$S_n = f \times S = \frac{P \times S}{p_1 \times 16} \quad (5)$$

The total stress in the loose strand of the belt is:

$$S_o = S_n - P$$

Example Showing how Formulas are Applied

Find the size of a rubber belt to transmit 300 horsepower at a speed of 3000 feet per minute. The smallest pulley is to be 36 inches in diameter, and the arc of contact 170 degrees.

The total turning or tangential force equals:

$$P = \frac{H \times 33{,}000}{V} = \frac{300 \times 33{,}000}{3000} = 3300 \text{ pounds}$$

The most effective speed for a belt of 28-ounce duck is 3000 feet per minute. In Table 3 we find the corresponding turning force p_1 per ply and inch of width for 170 degrees arc of contact and 3000 feet per minute velocity, to be 9.46 pounds.

The cross-sectional area of belt required is found by Equation (3):

$$f = \frac{P}{p_1 \times 16} = \frac{3300}{9.46 \times 16} = 21.8 \text{ square inches}$$

The total working stress for 28-ounce duck is 220 pounds, according to data previously given; hence, for a 36-inch pulley the maximum number of plies is found by Equation (2) to be:

$$N = \frac{D \times 2.4}{\sqrt[3]{S}} = \frac{36 \times 2.4}{\sqrt[3]{220}} = \frac{86.4}{6.037} = 14$$

This is the maximum number of plies which can be used on a 36-inch pulley, and inasmuch as the belt will undergo less strain when fewer plies are used, this number may well be reduced to ten. A further reduction may be necessary in order to have a well-proportioned belt. Considering a 10-ply belt and using Equation (4) the width of the belt is found to be:

$$W = \frac{f \times 16}{N} = \frac{21.8 \times 16}{10} = 34.9 \text{ inches}$$

The nearest width made in rubber belts is 36 inches; hence, a 10-ply rubber belt of 28-ounce duck, 36 inches wide, is required to transmit 300 horsepower at 3000 feet per minute.

Rubber belts are made either with a special friction surface or with a rubber cover and in almost any width. The number of plies ranges from two to fourteen. The commercial sizes usually kept in stock are from 1 to 26 inches in width and up to 6 plies. Heavier sizes are made to order. The various brands vary slightly in tensile strength and weight. The average weight of rubber belting per square foot and ply is: 0.3699 pound for 28-ounce duck; 0.3893 pound for 32-ounce duck; and 0.4923 pound for 36-ounce duck. To find the weight per lineal foot of a rubber belt, multiply the weight per square foot and ply by the number of plies and the width of the belt, in inches, and divide by 12.

* * *

FIXTURE FOR CUTTING HELICAL GEARS

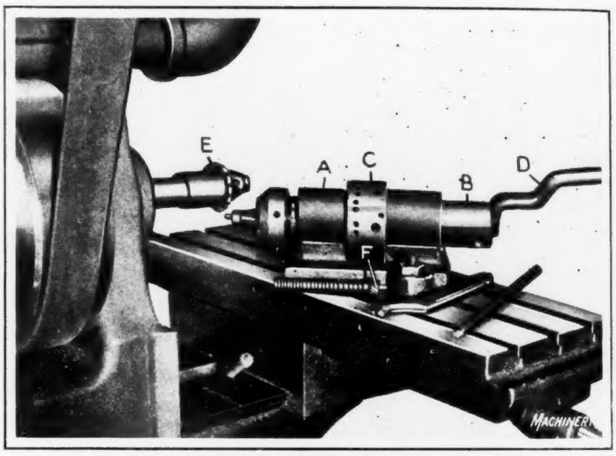
By DONALD A. HAMPSON

In production work, a drill jig is used for nearly every drilling job of any importance. Locating blocks or stops and efficient clamping devices incorporated in the drill jigs enable the workmen to perform the drilling operations quickly and accurately. No time is lost in locating the work or in making painstaking adjustments. Generally it is only necessary for the workmen to place the work in the jig, pull down or push over a clamping lever, and feed the drill to the work or to a depth determined by a stop. In some cases the feeding and even the clamping movements are automatic or power-operated.

While fixtures are provided for many milling operations on duplicate parts, they are not usually so efficient or simple as drill jigs. In many cases, however, they can be made much more efficient by applying some of the principles of design regularly employed in designing drill jigs, as was done in the case of the fixture shown in the accompanying illustration. This fixture is designed for use in cutting helical gear pinions on drawn steel pieces 5/8 inch in diameter. The outside diameter of the pinion is the same as the outside diameter of the steel pieces. The pinions, one of which is shown at *F*, are made in two types, both of which have twelve teeth cut at an angle of 45 degrees, the only difference in the pieces being in the length and size of the shafts. This difference, however, concerns only the selection of the collet used to hold the work when cutting the gear teeth.

The cost of cutting these gears is required to be kept low, yet the number of gears cut does not warrant the purchase of an automatic gear-cutting machine. In order to meet these conditions, the special fixture shown in the illustration was designed and used on a plain milling machine. The cast-iron body *A*, tongued to the milling machine table, and a work-holding spindle *B* set at an angle of 45 degrees, together with means for revolving and advancing the spindle constitute the essentials of the fixture. The spindle is 2 inches in diameter, and is made a close fit in the iron body. The inner end of the spindle is machined to fit work-holding collets for the different sized shafts.

Near the center of the fixture is located an index-ring *C* having twelve holes, or one hole for each tooth that is to be cut. This ring is made to serve two purposes—indexing, and controlling the lead of the spiral. The spiral-controlling feature is obtained by machining a chamber in the ring



Fixture used for cutting Helical Gears

which, when filled with babbitt, fits the square thread cut on the spindle and thus forms the lead nut.

In cutting a gear, the operator places the index-pin in any one of the holes in the index circle. The crank *D* at the rear end of the spindle is then turned to bring the work into contact with the milling cutter *E*. After completing a cut, the spindle is returned to the starting point, the index-pin withdrawn, and the ring turned until the pin can be placed in the next hole in the index circle. This operation revolves the spindle and the work 1/12 revolution, so that it is in position for cutting the next tooth space. As the index-ring nut is required to be a very close fit in the gap in the body *A*, provision is made for taking up any lost motion at this point.

* * *

OPERATING COSTS OF AUTOMOBILES

Bulletins have been issued by the Iowa State College, based upon careful records, indicating that the average cost of operation of automobiles in Iowa is 10.27 cents per mile, with depreciation and maintenance charges amounting to somewhat less than one-half of this amount, or about 5 cents per mile. The driving expense was 7.3 cents per mile, the remainder of the expense being fixed, whether the car was run or not. In making these estimates, it was assumed that the average life of a car is six years, and the total expected service of a new car was assumed to be 36,000 miles. Altogether, there are 536,000 passenger cars and 40,000 trucks registered in Iowa, and it is estimated that it costs somewhat over $400,000,000 for gasoline, oil, tires, repairs, interest, and depreciation annually to operate these vehicles. The bulletins from which this information has been obtained are Nos. 64, 65, and 67 of the Iowa Engineering Experiment Station, Ames, Iowa.

MACHINING AUTOMOBILE WHEEL HUBS

Automobile wheel hubs of the two-piece pressed-steel type shown in the machine in Fig. 1, are turned, faced, bored, and chamfered complete in an average time of 4 minutes, thirteen separate cuts being taken. This high production rate is obtained by using the tooling equipment illustrated, on a Cleveland 2-inch automatic. The most important features of this set-up are the arrangement by means of which the tapered portion of the hub is turned, and the construction of the chuck, which is air-operated.

From the plan view shown at the right in Fig. 2, it will be seen that attached to the headstock spindle is a plate on which four pins *A* are mounted. In putting a hub into the machine, the four flange holes are seated on the small ends of pins *A*, and then the air valve of the chuck is operated to push forward bar *B*. With this action, the tapered portion of the bar causes links *C* to swivel and exert pressure against the large hole in the work, securely holding the work for the operation. Pins *A* are used both to locate and drive the work, and as all thrusts are toward the headstock, there can be no longitudinal movement of the work.

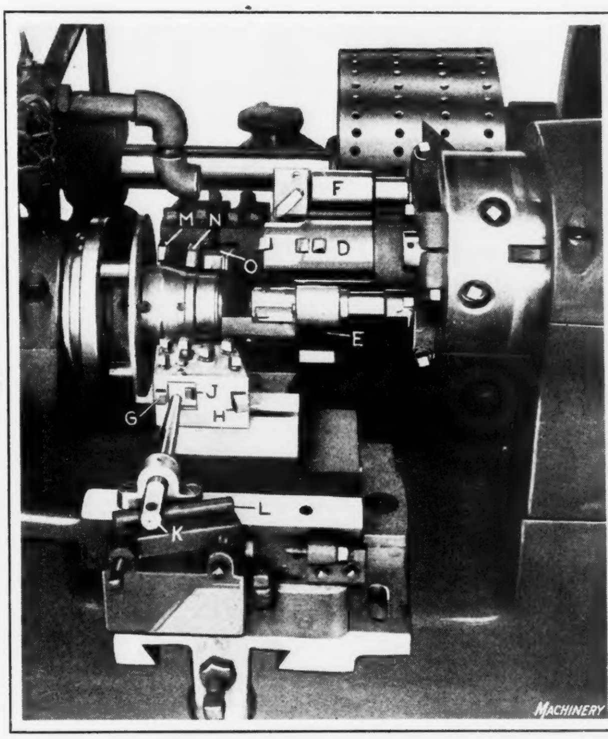


Fig. 1. Tooling Equipment used on a Cleveland Automatic for machining Automobile Wheel Hubs

The first step consists of using simultaneously the turning-bar *D* and boring-bar *E*, which are shown in Fig. 1, and at the left in Fig. 2. Bar *D* carries three cutters for rough-turning three straight surfaces of different diameters, and the boring-bar carries four cutters, two for rough-boring the small diameter end, and two for chamfering the hole at this end. When this step has been completed, the turret is indexed to bring boring-bar *F* into alignment with the center of the spindle, as shown at the right in Fig. 2. This boring-bar is employed simultaneously with the front and rear tool-slides. There are four tools in boring-bar *F*; two of these are used for finish-boring the small end of the hub and the other two for counterboring it.

Tools *G* and *H* on the front slide are used to turn a second time two straight surfaces of the hub as the slide is fed to the left. Between these tools is a sliding block *J* in which is contained a third tool for rough-turning the tapered portion. Obviously a lateral movement must be given to the third tool, in combination with the longitudinal movement. This lateral movement is accomplished by means of rod *K*, Fig. 1, in the following manner:

One end of rod *K* is connected to block *J* in which the taper-turning tool is held, and fastened to the opposite end of rod *K* is a roller that travels in a path in guide *L*, which is attached in a stationary position at the front of the machine. This path is inclined at the same angle as the tapered portion of the hub, so that block *J* is withdrawn at the required rate in relation to the longitudinal movement. Rod *K* is supported near the outer end by means of a bearing as shown. Three tools are also mounted on the rear slide, and these are fed forward into contact with the work. Tool *M* faces the flange; tool *N* finish-forms the tapered portion; and tool *O* finish-turns and faces five separate surfaces on the small end of the hub, ready for the threading operation.

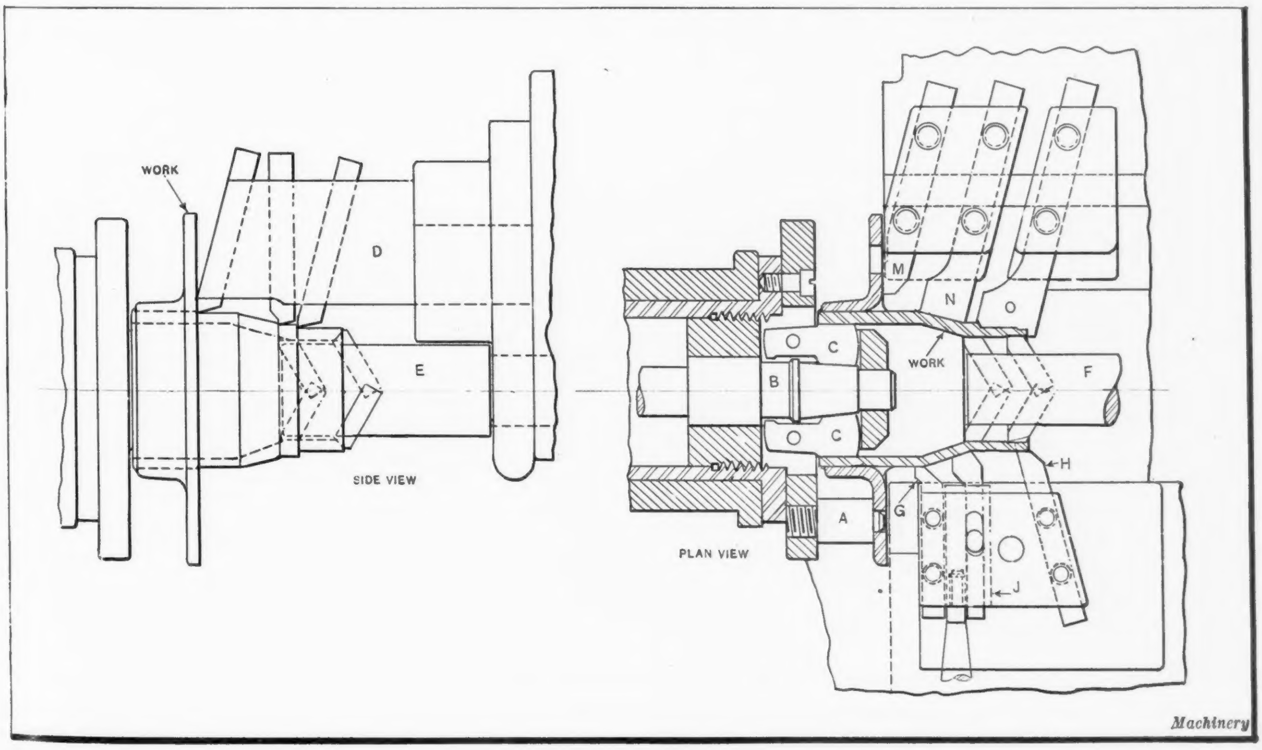


Fig. 2. Lay-outs of the Tooling Equipment used for the Wheel Hub

Valve Mechanisms in Automatic Machinery

By ALBERT A. DOWD

THE method of handling semi-fluid substances which flow slowly depends largely on the viscosity of the material. Oily matter may require different treatment from something that is sticky. The control of the flow from the hopper or tank often requires considerable study and sometimes experiment before the best method can be determined. Gravity feed can seldom be used successfully, because it is neither rapid nor accurate enough to depend upon. Occasionally sticky or gummy substances cause much trouble by adhering to everything they touch. All units with which such materials come in contact must therefore be designed so that they can be disassembled easily for cleaning. The greatest care is also necessary to prevent waste in the form of overflow. To the best of the writer's knowledge, all valves will drip a trifle for a moment or two after they have been closed, and when this drip is objectionable, means must be provided to take care of it in some way. A valve may be perfectly tight after it is closed, but there is always a small amount of liquid that does not flow immediately.

A machine was designed for depositing semi-liquid water color paint on a card in the form shown at *A* in Fig. 1. Different colored paints were contained in six tanks *B* above the machine, and the card *C* was fed into the position shown. The cardboard had been previously pressed into circular depressions in six places, as shown in the enlarged section *X–Y*, so as to hold the paint. In this machine, the table *D* is mounted on a shaft *F* having a roller *G* at the lower end which comes in contact with the cam *L*. This causes the table to move upward until the card strikes the

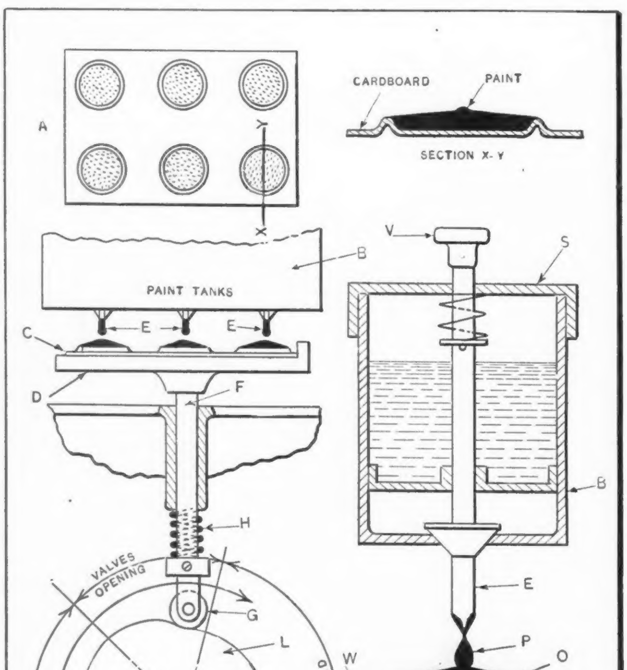


Fig. 1. Machine for depositing Semi-liquid Water Color Paints

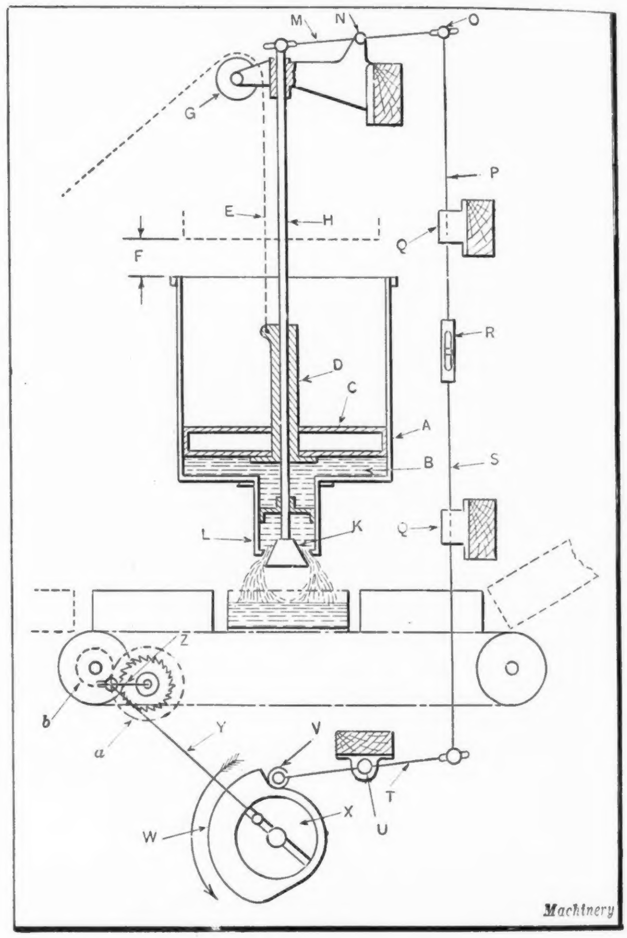


Fig. 2. Feed Tank for Semi-fluid Substances

plungers *E*, which action results in opening the tank valves and allowing the paint to flow until the cam has revolved to point *M*, when the roller drops and the table is quickly forced down by the spring *H*. As the valves close by springs, the liquid ceases to flow as soon as the valve closes, but in the first design a troublesome drop always remained on the ends of the plungers and frequently dropped on the card during its removal from the machine, causing one or more "smears" which made the product unsaleable. Aside from this, the machine functioned in a satisfactory manner, but this one point was enough to condemn it, as eight out of ten cards were smeared during the operation.

The trouble was remedied by providing a new cam having a "hump" on it at *N*, as shown by the dotted lines. This hump caused the table to move upward again immediately after the valves had been closed and by just touching the drops hanging to the plungers, remove them as shown in the large detail. The drop *P*, as soon as it touched the larger mass of paint *O* drew away from the plunger and united with the material in the cup. The knob *V* allows the plunger to be lifted by hand when necessary. This example shows how easily a small defect may make an otherwise good machine worthless. Remedies applied after building the machine are costly, and forethought combined with experiment will usually make them unnecessary.

Semi-fluid substances often move so sluggishly that it is necessary to use pressure to speed up the flow. The best and surest way of doing this is by means of a pump or similar suction device. Exact quantities can be obtained only

by these methods. The method to select depends somewhat on the nature of the material and the relative cost of the units required. The designer must be governed by conditions, using ideas which previously have been found satisfactory and which will not be too expensive.

Fig. 2 shows an application of a tank and valve arrangement for feeding a heavy mixture into containers which pass under the spout shown. A device of this kind can be used when the material is of the consistency of heavy paints or oils. The cylindrical tank *A* holds the mixture *B*, on top of which rests the sheet-metal drum *C*. The drum fits the inside of the tank closely, and is fastened to a long central hub *D* which is a sliding fit on the valve rod *H*. The valve portion *K* is screwed to the end of the rod so it can be easily removed for cleaning. There are two common methods of applying valves of this form; with the point of the cone down or as shown in this example. If arranged with the cone point down, the valve closes more readily, as it is assisted by the pressure of the liquid. The spreading of the mixture may affect the form used. With the type shown, the material flows down and spreads out, falling into containers. The spout *L* should be readily detachable to permit cleaning. Chain *E* runs over sheave *G* and facilitates raising the drum to position *F* for filling the tank or for other purposes.

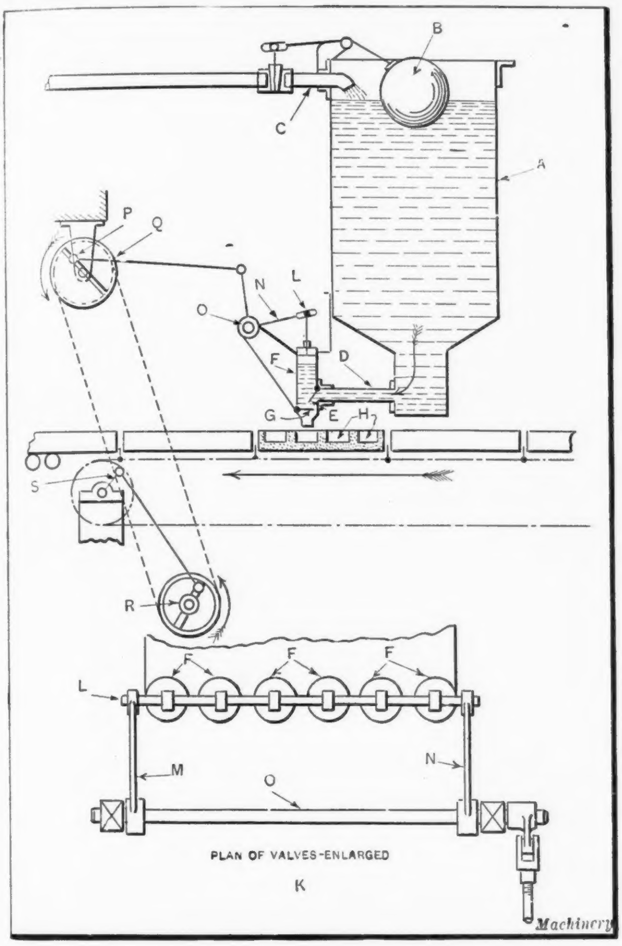


Fig. 3. Valve and Tank Arrangement for Pasty Fluids

The operation of the valve is through lever *M* pivoted in a bracket at *N*, thence through the various connections shown to the roller *V*, which is controlled by cam *W*. Rod *Y* connects with *X* and operates a pawl on lever *Z*, moving the ratchet wheel shown. The conveyor chain is thus driven intermittently through gears *a* and *b*. This construction makes it easy to time the movements of the conveyor with the closing of the valve. The example is given only in diagrammatical form, it being understood that the form of cam would naturally be made to suit the conditions. The drum type has a number of advantages and is often used instead of the style shown.

Another method of controlling the flow from the tank would be by means of a worm and gear driving a pinion meshing with a rack on the drum hub or an extension suitably placed. If this were done, the feed would be by power instead of by weight, and a compensator in the form of a friction clutch should be interposed between the power unit and the pinion so that the pressure on the liquid could be regulated to suit the mixture.

Valve and Tank for Pasty Fluid

The diagram Fig. 3 illustrates the application of the pump principle in feeding heavy liquids. The problem here is to deposit a specified amount of candy paste in molds which pass intermittently under a series of nozzles, stopping for a moment to receive the discharge. The mixture is contained in the tank *A*, the quantity being regulated by a float *B* which operates a shut-off valve in the supply pipe *C*. The lower portion of the tank has six outlets *D*, leading through the valves *E* into the small pump cylinders *F*. At the bottom of these cylinders are other valves indicated at *G* leading to spouts through which the fluid is discharged into the molds *H*.

The enlarged plan view at *K* gives a good idea of the general arrangement. All the pump plungers are connected by a cross-rod *L*, which is moved up and down by the two levers *M* and *N*, these being fixed to the rocker-shaft *O*. The stroke of the plungers is adjustable by changing the position of the stud *P* in the slotted plate *Q*. This makes it possible to deliver the exact quantity required into the molds at each stroke of the plunger. The movements are timed from the main driving shaft *R*, from which the intermittent movement of the conveyor is transmitted through a ratchet and pawl at *S*. The advantage of using a pump arrangement for work of this kind lies in the fact that the quantity of material delivered to the molds can be measured accurately, thus avoiding overflow or waste.

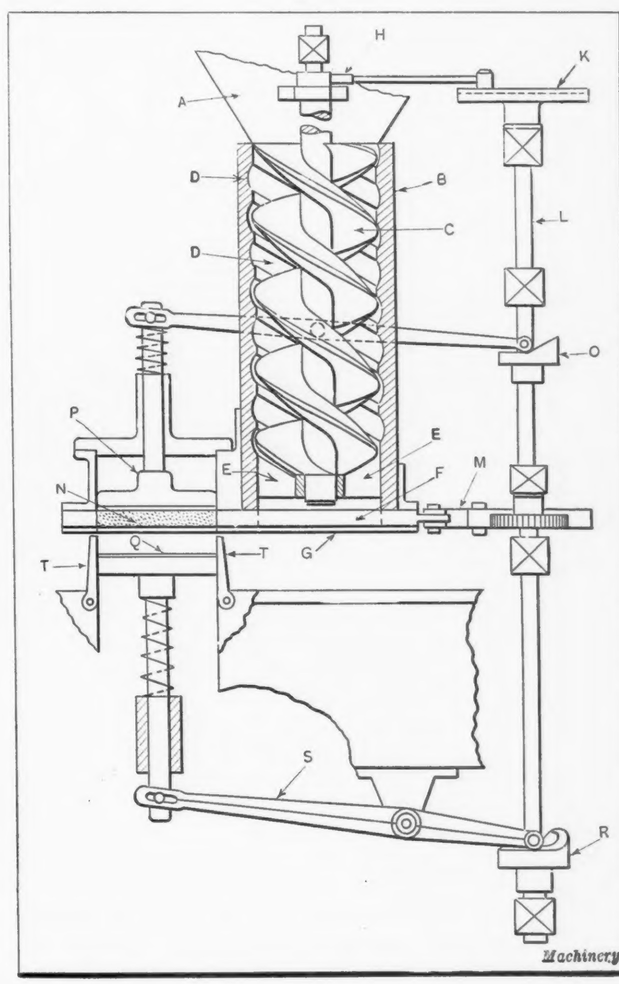


Fig. 4. Feeding and Molding Device for Heavy Mixtures

Handling Stiff and Gummy Materials

From semi-liquids the next step is to those materials that are of heavy pasty form, the consistency and elasticity of the mixture being governing factors. It is unwise to design an automatic feeding device for any heavy mixtures without first conducting some experiments to determine the best method of procedure, for although long experience indicates that a certain substance can be readily fed with a given type of mechanism, an experiment may demonstrate that some other scheme is better. Let us take the example shown in Fig. 4, which is a feeding and molding device for materials of about the consistency of butter.

The requirements of this machine are that it must feed the mixture into a mold from which it is afterward ejected and wrapped. The mixture is contained in a conical hopper *A*, and is fed down through the portion *B* by means of a worm *C*. In making a preliminary test with a worm in a smooth cylinder, it was found that the material would not feed downward, but collected on and revolved with the worm. To counteract this tendency, the inside of the hopper was formed into a series of grooves *D* similar to a steep-pitch thread. The worm itself is left-hand and the grooves are right-hand, so that when the worm turns, the action tends to force the material down along the grooves through the opening at *E*. As it passes through, it enters the mold plate *F* which lies over a guard *G*, thus compressing the material until it fills the space in the mold plate.

The worm operates intermittently through a ratchet and pawl at *H*, adjustment for the stroke being provided by the slotted plate at *K*. The shaft *L* also controls the movement of a slide *F* through a pawl and link motion at *M*. This movement is timed so that it goes into action immediately after the mold has been filled, and moves the latter over until it takes the position *N*. At this point another cam *O* on shaft *L* causes plunger *P* to push the material out and down on the table *Q*, where a piece of tinfoil is placed to receive it. The cam *R*, acting through a lever *S*, pulls the table down, and the fingers at *T* fold the tinfoil upward during the process. All movements are taken from the same shaft in order to obtain correct timing. The details of the mechanism do not require lengthy description, but it is well to call attention to the importance of the metal which comes in contact with the product. Owing to the fact that there are acids which would tend to corrode brass or steel, it was found necessary to make the mold *F* of stainless steel, and other parts that came in contact with the material or that were subject to corrosion were given a heavy plating of tin. All parts were so made that they could be removed easily for washing in hot water.

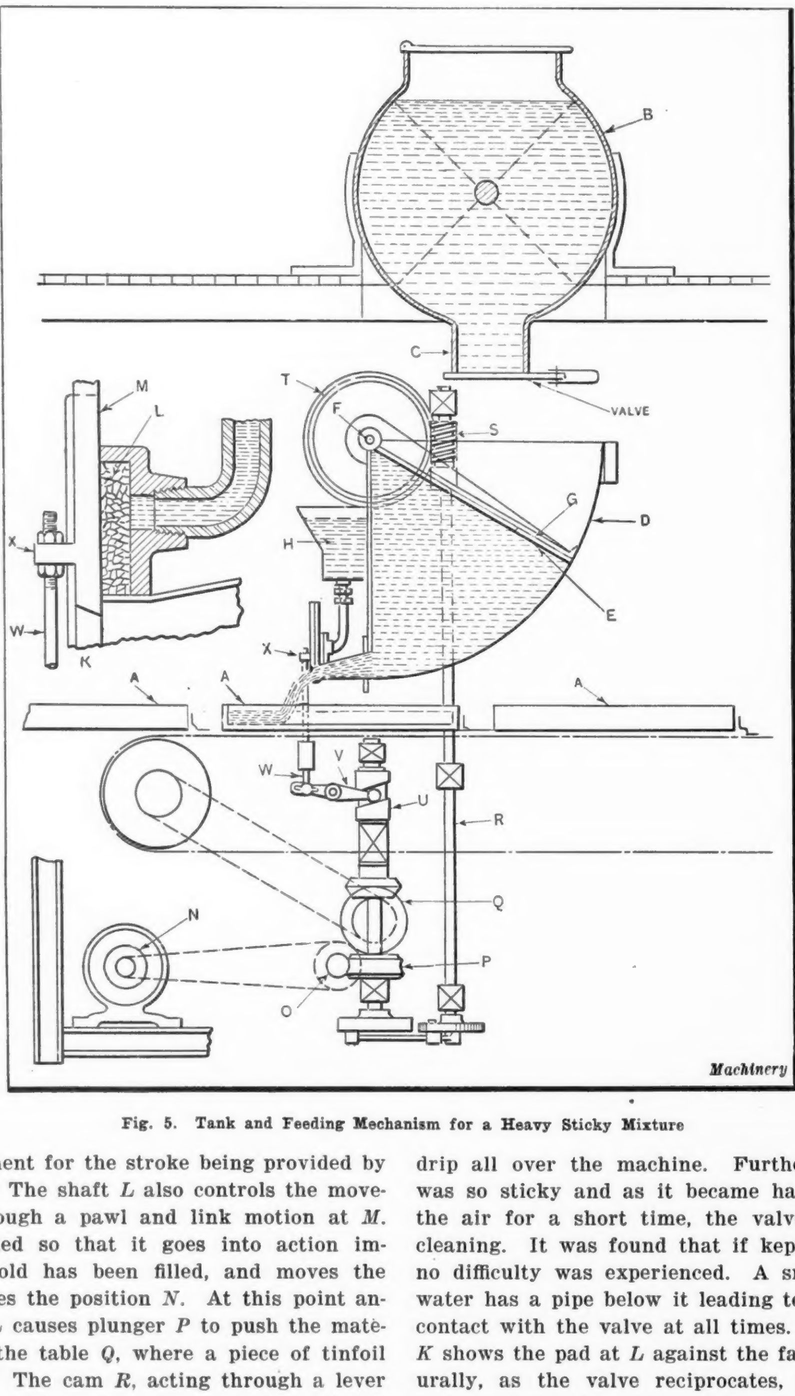


Fig. 5. Tank and Feeding Mechanism for a Heavy Sticky Mixture

Mechanism Used for Heavy and Sticky Mixtures

In Fig. 5 is shown an example of a device for handling material almost identical in consistency with that used in the last example. However, there is a decided difference in the viscosity of the mixture, as the one we are now considering is very sticky and elastic. By experiment it was found that ordinary methods of feeding were not successful, and the mechanism shown was finally used to solve the problem. The mixture was to be laid in a strip $1\frac{1}{2}$ inches thick in wooden trays *A* which were well greased with cocoa butter before feeding them into the machine. The material was prepared on the floor above, in a beater shown at *B*. A spout *C* at the bottom of the beater is directly over the tank *D*. The shape of the tank is such that a swinging piston *E* pivoted at *F* follows the contour and gradually forces the material out through the spout in the form desired as the trays *A* pass under it. Shortly before the end of each tray is reached, the shut-off valve operates and cuts off the supply. The piston *E* has a sliding cover *G* which can be quickly removed, leaving an opening directly beneath the spout *C* when filling.

Several problems were involved in this design, one of the most important of which was a method of cutting off the supply quickly and not leaving a mass of material to drip all over the machine. Furthermore, as the mixture was so sticky and as it became harder after contact with the air for a short time, the valve had to be made self-cleaning. It was found that if kept wet with plain water, no difficulty was experienced. A small tank *H* filled with water has a pipe below it leading to a felt pad which is in contact with the valve at all times. The enlarged detail at *K* shows the pad at *L* against the face of the valve *M*. Naturally, as the valve reciprocates, its face is continually moistened by the water, which cleanses it and keeps the material from sticking to it.

The operation of the various units is as follows: The drive comes from a motor shown at *N*, a belt being used to drive the worm *O* which meshes with worm-wheel *P* on the main drive shaft. From this all the movements are obtained as required. First, the trays are driven by a chain and sprocket through the bevel gearing at *Q*; then

by means of ratchet and pawl, the shaft R is rotated intermittently, which causes worm S to act on the large wormgear T through a friction clutch on shaft F governing the movement of the swinging piston E. A friction drive is interposed in order to prevent too much pressure being developed in the tank. The shut-off valve is operated by a cam U acting on lever V, which pulls down the rod W connected to the valve, as shown at X in the large detail. The movement of the trays is continuous, and the shut-off valve operates just before reaching the end of the tray, opening again as the next tray passes under it. This machine in itself is comparatively simple, but the principles involved were only determined after considerable experimenting, a small tin model being made and actually tried out before deciding upon the method most suitable.

It does not seem necessary to take up any more examples of liquids and semi-liquids, but it is advisable to emphasize the importance of experiments with any of these materials before proceeding with the actual design. There are so many factors involved that without such experiments the chances for success are small. Often when a machine is to be designed for handling certain kinds of material, it is possible to obtain a great deal of information by making a trip through the factory where the installation is to be made and noting the methods used during the process of manufacture. In this very case the writer visited the factory, taking note that the material was taken from the beater B in tubs and dipped from these with a large tin dipper and spread in the trays by another man with a wooden spreader which was continually dipped in water and wiped off as each tray was filled. So, in any kind of a feeding device, a thorough knowledge of the material handled must be gained by first-hand information and actual experiment.

* * *

CUTTING TOOLS MADE OF CAST IRON

By HERBERT A. FREEMAN

When only a few pieces are to be turned to a special form, it is sometimes possible to cut down the tool expense and still obtain satisfactory results by using chilled cast-iron tools. A forming tool of this kind, provided with a shank that can be gripped in an ordinary toolpost, is shown at A in the accompanying illustration. The upper surface of the formed part of this tool is made very hard by chilling when the mold is poured. When carefully sharpened, a tool of this kind, which has been properly designed, will give good service for a short time, especially in cutting through scale or the tough outer skin of castings. It also gives exceptionally good results in machining phenolic condensation products which are very hard on steel tools.

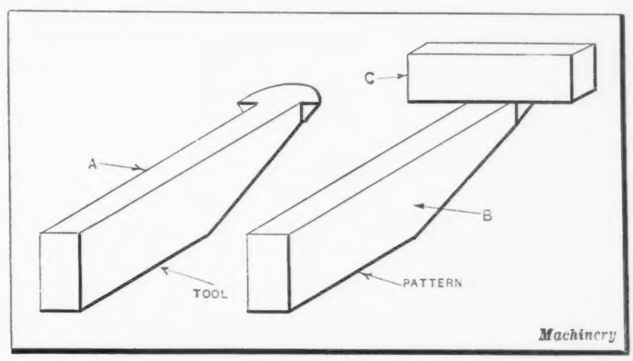
At B is shown the pattern used in making the mold for tool A. The detachable rectangular piece or print C is made about 1 inch deep, 1 inch wide, and 3 inches long. This piece has a slight taper or draft which permits it to be easily withdrawn from the mold. A piece of cold drawn steel, 1 inch square by 3 inches long, known as a "chill" is placed in the cavity left in the mold by the withdrawal of the print. The hot iron flowing into the mold strikes the chill and is thus cooled suddenly. The surface that is in contact with the chill will become glass-hard if it is kept in contact until fully solidified. With a chill of this size, the metal will be hardened to a depth of about 3/32 inch. Any number of molds can be made from one pattern, but as many chills as there are molds to be poured at one heat must be provided.

A tool made in the manner described can sometimes be hardened if heated to a bright cherry color and quenched in water. The molecular changes in the iron are transitory in nature, and succeed each other so rapidly that it is difficult to quench the work at exactly the right point. Unfortunately, the edges of tools made in this manner are very brittle, and if thrown about or allowed to fall on the floor, they are almost sure to be nicked. Care should be taken not to back the tools out from the work while there is a chip on the lip or cutting edge. Nicking will even occur when cutting cast iron with a tool having no top rake, if it is backed out from the cut when not entirely free from the chip. This point should be borne in mind when designing the cams for an automatic machine in which cutting tools of cast iron are to be used.

When making patterns for the cast tools, the formed edge should be worked out in the pattern as accurately as possible. After a tool casting has been cleaned, it can be ground as accurately as the requirements of the job demand. The writer is using quite a number of circular forming tools having convex profiles formed to various radii. A special clamp or fixture has been attached to the drill grinder for use in grinding the different sizes of tools to the required curvature and clearance angles.

Helical Cutters Made from Chilled Castings

While the process of making helical cutters that is to be described is more or less of an experimental nature, it has been used with good results. First, a pattern for a cylinder having a diameter 2 inches greater than that of the required cutter and about 1/8 inch thicker, is made up. A ring bushing having the same outside diameter and thickness as the pattern and an inside diameter 1/4 inch greater than the



Cast-iron Tool and the Pattern used in its Production

outside of the finished cutter is made. In making the casting for a cutter, the metal ring is used as a chill, and as soon as the mold is poured, the casting is knocked out from the sand and the chill. The bore of the chill should be given a slight draft to facilitate this operation. The hotter the casting, when knocked out from the ring, the better will be the results obtained. The object of this process is to change the structure of the outer portion of the casting, while the inner portion is still in a molten state.

If the work has been properly done, the casting will have, when cooling, beads of molten metal which have seeped through the contracting skin of the casting as a result of the enormous shrinkage pressure. A casting produced in this manner will be found to be as soft as an ordinary one, and can be bored, turned, and gashed in the usual manner. After it has been machined, it is heated to a bright cherry color and quenched. After sharpening, the cutter made in the manner described will often given surprisingly good results, but it cannot be annealed and rehardened.

The same procedure may also be followed in making dies. One of the advantages of the method, when applied to this kind of work, is that very little distortion or warping takes place. Also, the castings do not "grow," as is often the case with ordinary cast iron when reheated.

* * *

RENSSELAER CENTENNIAL

The Rensselaer Polytechnic Institute, Troy, N. Y.—the oldest school of science and engineering in any English-speaking country—will celebrate the one-hundredth anniversary of its foundation October 3 and 4. The celebration will be attended by delegates from educational institutions, scientific organizations, and engineering societies throughout the world.

What Our Readers Think

on Subjects of General Interest in the Mechanical Field

THE TAX ON MECHANICAL INFORMATION

The following comments on the subject of postal rates for second-class mail matter have been received: "The article in June MACHINERY on proposed increases in postal rates has been read by the writer with a great deal of interest. From the facts and figures quoted, it is evident that, even without further increases in postal rates, mechanical periodicals like MACHINERY, devoted to the spreading of information essential to the men engaged in the machine-building industry, are being taxed in excess of other business enterprises by the collection of second-class postage rates. These rates appear to be much greater than necessary to pay for the service rendered by the postal department in carrying this class of mail matter. Those who really suffer from such unjust legislation are the readers of mechanical journals, because it is evident that this discrimination against publishers hampers the spreading of technical and business information and prevents mechanical and other business journals from rendering a full measure of service. Some members of Congress have recognized this discriminatory form of taxation and are advocating fair play, but will their voices be heard?"

Another reader writes: "Commenting upon your article on proposed increases in postal rates in June MACHINERY, it seems to the writer that if publishers pay the same tax as all other enterprises, and I presume that they do, because I never heard of any exceptions made in regard to tax-paying in the case of any really useful undertaking, there certainly is no reason why mechanical publications should be asked to pay an additional tax in the form of excessive postal rates. The rates should be adjusted so as to pay for the services rendered by the postal department, and no more. In the engineering field especially, it is of great importance that information as to new methods and devices, improvements in design, new discoveries, and general industrial progress, be quickly and easily spread to the great number of people engaged in the industries upon which, to a very large extent, the prosperity of the country depends. To hamper the spreading of such information by what is in reality a discriminatory tax, is to hamper industrial progress; and to hamper industrial progress means a curtailing of business activities, a falling off in prosperity, and ultimately a reduction in the income of the Government itself through the reduced taxes that will be received from industry."

METHODS OF PAYING APPRENTICES

The writer recently had an opportunity to talk with a manufacturer in a Middle Western city, who expressed the opinion that present apprenticeship contracts do not provide the required stimulus to a boy who starts to learn a trade. He said that modern methods of education take more and more into account the need for arousing the interest of the child or student in the subjects studied. Manufacturers, in solving the apprenticeship problem in a satisfactory manner, would have to consider the same principle, but at the same time they should take into account the fact that the boy may not be interested in the character of the work alone, but also in the amount of the compensation. This manufacturer does not believe in an apprenticeship contract that determines the pay of a boy beforehand. He believes that some kind of a sliding scale should be adopted so that the boys who show the best mechanical ability would receive compensation accordingly. Sometimes a boy, after two or three years training, finds that he is able to do work that is equal both in quantity and quality to that performed by the average journeyman. If then he receives but half the wages paid to a journeyman, he will naturally lose a good deal of his enthusiasm. He needs the stimulus of immediate reward and should be made to feel that earnest effort will produce increased returns, not only after the four years of apprenticeship are completed, but right now.

The writer knows of one apprenticeship contract that was used some years ago by a Connecticut firm in which certain bonuses in the form of increased hourly rates were paid to apprentices whose records were exceptionally high. This idea may be the best solution of the problem. It provides for a definite standard, which is necessary in any apprenticeship system, but it also provides for a variation in compensation according to ability. OBSERVER

EXTRAVAGANT USE OF HIGH-SPEED STEEL

Some toolmakers and machine shop foremen seem to think that simply because high-speed steel renders such excellent service under many severe cutting conditions, it invariably follows that it is the best material to use for practically all cutting tools as well as machine parts particularly subjected to wear. This is a wrong idea, because plain carbon tool steel will frequently give longer service, and at the same time is cheaper. Also alloy tool steel not in the high-speed class often has a greater resistance to wear. It is for this reason that a low-tungsten tool steel has become popular as a material from which to make power press dies.

The principal feature of high-speed steel is that it will continue to cut metals even if the point of the tool becomes heated to a dull red, or to a temperature of 1100 or 1200 degrees F. Because of this property, high-speed steel is so far superior to carbon tool steel for cutting metal rapidly that it revolutionized machine shop practice when first introduced to the trade. However, it is hardly probable that high-speed steel is more economical for hand reamers and similar tools used under circumstances in which there is no danger of the cutting edges becoming excessively heated.

High-speed steel is often recommended for a job because it is easy to heat-treat. Carbon tool steel does require skillful heat-treating, and unfortunately toolmakers have become so used to high temperatures in heat-treating high-speed steel, that carbon tool steel is often subjected to too great temperatures, with the result that a coarse grain is produced, and the life of the tool is shortened. Nevertheless, with careful heat-treatment, carbon tool steel will render satisfactory and long service for many classes of work. When it can be used satisfactorily, it is obviously uneconomical to use high-speed steel. H. K. W.

DO WE THINK?

I have noted with considerable interest the new department in MACHINERY called "What Our Readers Think," and hope this will serve as a stimulus to the men in the mechanical field to exchange ideas. The trouble with most of us is that we don't do much individual thinking—we take too much for granted. In some cases we do our jobs in routine fashion, without even asking the why and wherefore of the various steps. Let's try to do more thinking, and pass on the result of our thinking for the benefit of the other fellow. Progress is based on cooperation. E. ROBERTS

Making Master Threading Tools

By G. D. HUTCHINGS

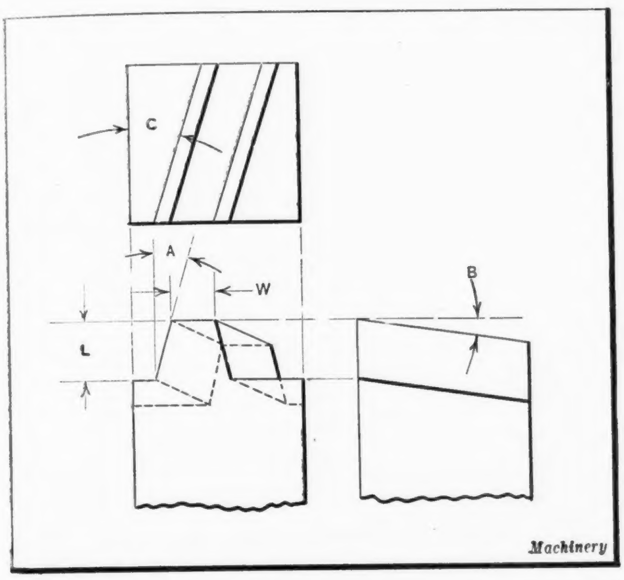


Fig. 1. Tool for threading Hobs

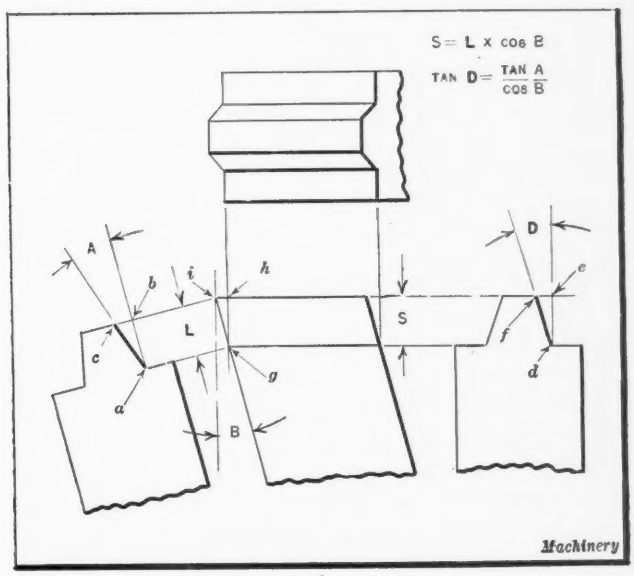


Fig. 2. Plain Forming Tool

THE data given in this article have been prepared for use in making theoretically correct master tools for hobs or any similar thread-cutting tools. The formulas presented herewith do not provide for side clearance, but if the clearance angle B, Fig. 1, is made large enough—say about 20 degrees—it will not be necessary to provide any additional side clearance.

Referring to Fig. 1, let

A = angle to be produced on work;
B = clearance angle of tool;
C = helix angle of thread;
W = width at bottom of tooth space; and
L = depth of cut.

Fig. 2 shows a plain forming tool. For the purpose of simplifying the calculations, let $L = 1$ inch. Then in the right-angle triangles abc and def, $bc = ef = \tan A$.

Also in the right-angle triangle ghi, $S = L \times \cos B$, and since we let $L = 1$ inch, $gh = de = \cos B$.

Therefore,

$$\text{Tan } D = \frac{ef}{de} = \frac{\tan A}{\cos B}$$

Referring to Fig. 3, the angle C, or helix angle, lies in the plane de, and angle E lies in the plane df.

Let $de = 1$ inch. Then $df = \dfrac{1}{\cos B}$. Also in the right-angle triangles hij and klm, $ij = lm = \tan C$, and $df = kl$.

Therefore,

$$\text{Tan } E = \frac{lm}{kl} = \frac{\tan C}{1 \div \cos B}$$

or

$$\text{Tan } E = \tan C \times \cos B$$

Fig. 5 shows the set-up for milling the threading tool, and also the normal section through the tool and the fly cutter. In the right-angle triangles abc and def, let $ab = de = 1$ inch. In the triangle abc, $bc = \tan D$, and in the triangle def, $ef = \cos E \times \tan D$.

Then,

$$\text{Tan } H = \frac{ef}{de} = \frac{\cos E \times \tan D}{1}$$

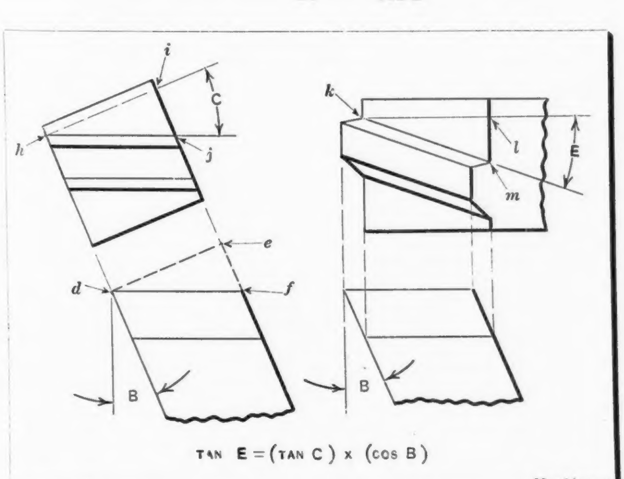


Fig. 3. Diagrams used in calculating Angles for Threading Tools

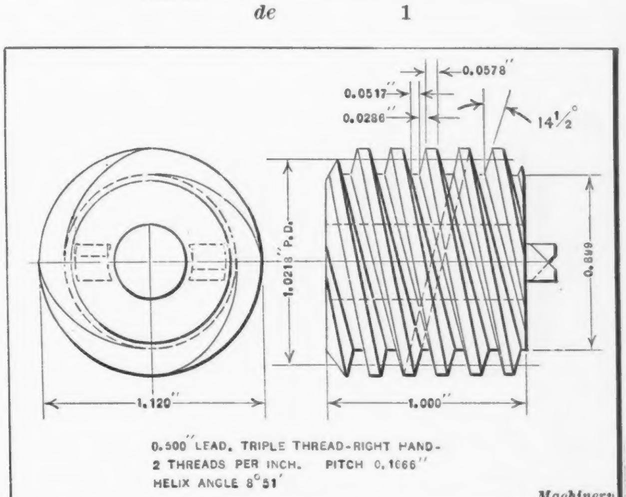


Fig. 4. Worm having Threads cut with Threading Tool

But from the second equation given in Fig. 2,

$$\text{Tan } D = \frac{\tan A}{\cos B}$$

Therefore, by substituting this value for tan D, we have, as given in Fig. 5,

$$\text{Tan } H = \frac{\cos E \times \tan A}{\cos B}$$

Also,

$$N = W \times \cos E$$

The next step will be to revolve the tool around the line YY, Fig. 5, in order to get the face of the tooth in a vertical position, for the purpose of grinding or checking. Since $de = 1$ inch in the triangle def, we have $ef = \tan H$. Then in the right-angle triangle ghi, $hi = \cos E \times \tan H$. Also, $gh = 1$ inch.

Now referring to Figs. 5 and 6, we have

$$\text{Tan } R = \frac{hi}{gh} = \cos E \times \tan H$$

Likewise in the right-angle triangle, jkl, $jk = 1$ inch, and $kl = \sin E \times \tan H$.

Therefore,

$$\text{Tan } K = \frac{kl}{jk} = \sin E \times \tan H$$

It can now be readily seen that by inclining the tool backward from the position shown in Fig. 5, through angle R, and then sidewise through angle K, the face of the tooth will be in a vertical position, as shown in Fig. 6. In this illustration the tool is shown mounted on an inclinable angle-plate. Now by swinging the angle-plate around through the angle E, we have the grinding position.

For checking purposes, the inclinable angle-plate may be mounted on the side of a 90-degree angle-plate, at the angle E, so that the face of the tooth will be in a horizontal position. The accuracy of the face of the tooth may then be determined by sliding a dial indicator (mounted on a surface gage) over the face of the tooth.

For example, suppose it is required to make a threading tool for the worm shown in Fig. 4. Referring to the notation in Figs. 1 and 2,

A = 14 degrees 30 minutes = angle on side of tooth;
C = 8 degrees 51 minutes = helix angle of thread;
W = 0.0517 inch = width at bottom of tooth space; and
B = 20 degrees = clearance angle of tool.

In this problem assume S = 3/16 inch, which is greater than the depth of the cut. Referring to Fig. 3,

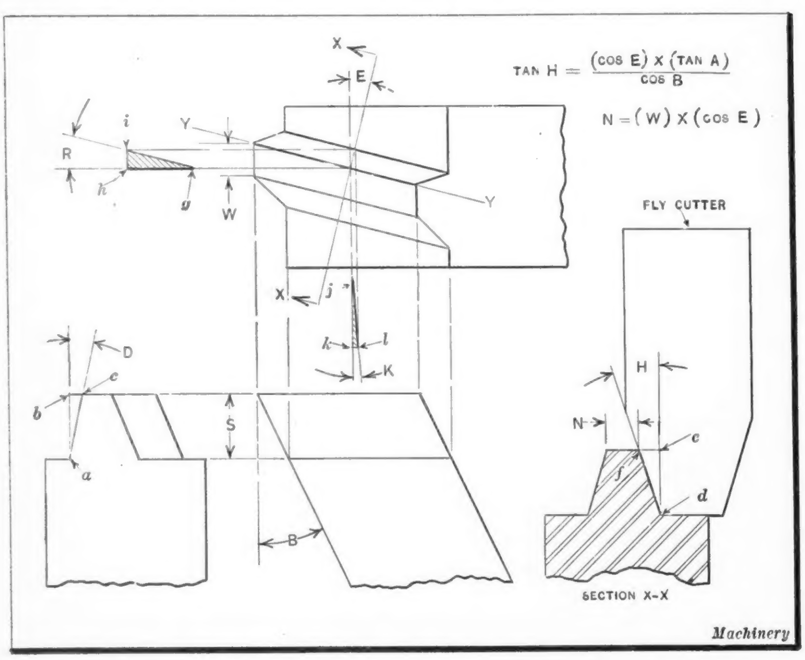


Fig. 5. Diagrams used in calculating Angle of Fly Cutter for milling Threading Tool

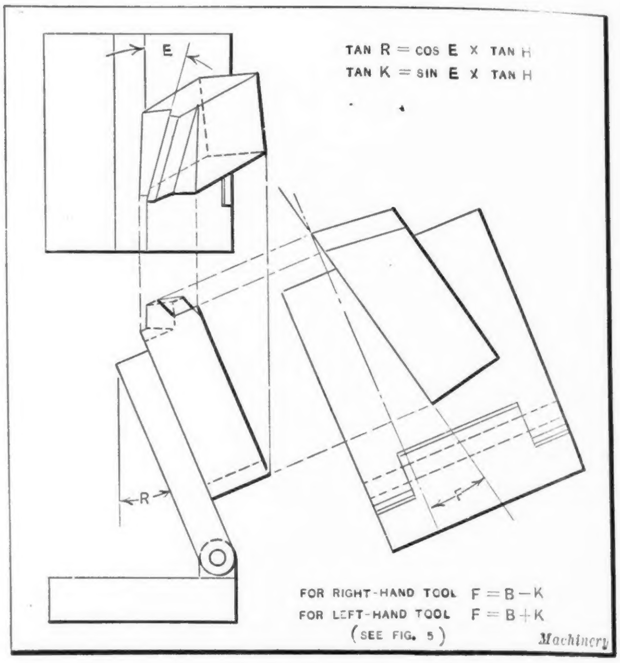


Fig. 6. Set-up Diagram showing Side of Threading Tool in Vertical Plane Ready for Grinding

$$\text{Tan } E = \tan C \times \cos B$$

Substituting the numerical values,

Tan E = tan 8 deg. 51 min. × cos 20 deg. = 0.15570 × 0.93969 = 0.14631

and

E = 8 degrees 19 minutes 26 seconds

Now referring to Fig. 5, we have:

$$\text{Tan } H = \frac{\cos E \times \tan A}{\cos B} = \frac{\cos 8 \text{ deg. } 19 \text{ min. } 26 \text{ sec.} \times \tan 14 \text{ deg. } 30 \text{ min.}}{\cos 20 \text{ degrees}} = \frac{0.98946 \times 0.25862}{0.93969} = 0.27232$$

and

H = 15 degrees 14 minutes

From Fig. 5,

$$N = W \times \cos E$$

Substituting the numerical values,

N = 0.0517 × cos 8 degrees 19 minutes 26 seconds = 0.0517 × 0.98946 = 0.0511 inch

Now, referring to Fig. 6 we have:

Tan R = cos E × tan H = cos 8 deg. 19 min. 26 sec. × tan 15 deg. 14 min. = 0.98946 × 0.27232 = 0.26945

Then

R = 15 degrees 4 minutes 48 seconds

Now

Tan K = sin E × tan H = sin 8 deg. 19 min. 26 sec. × tan 15 deg. 14 min. = 0.14476 × 0.27232 = 0.03942

and

K = 2 degrees 15 minutes 26 seconds

Since this is a right-hand tool, we have:

$F = B - K$, as shown in Fig. 6. Now

$B - K$ = 20 deg. — 2 deg. 15 min. 26 sec. = 17 deg. 44 min. 34 sec.

On detail drawings of hobs, it is common practice to show a normal section through the tooth, but before the formulas for making master tools can be applied, it is necessary to determine a section through the tooth

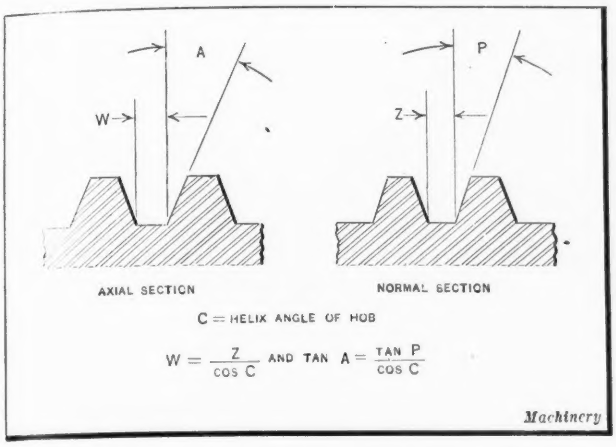


Fig. 7. Diagrams and Formulas for finding Form of Thread in Axial Plane

along the axis of the hob. The formulas given in Fig. 7 may be used to find the dimensions of the axial section from the dimensions of the normal section.

* * *

ADJUSTABLE CAMS

By E. E. LAKSO

In designing machinery for certain purposes, it is necessary to provide means for adjusting the cams in order to compensate for wear, alter the timing, or obtain other desirable effects. Fig. 1 shows a solid cam fashioned in such a manner as to permit it to be adjusted for an early or late throw. This cam has a keyway in it which is a sliding fit on a key in the shaft. The adjustment is accomplished by sliding the cam sidewise on the shaft, the cam being held

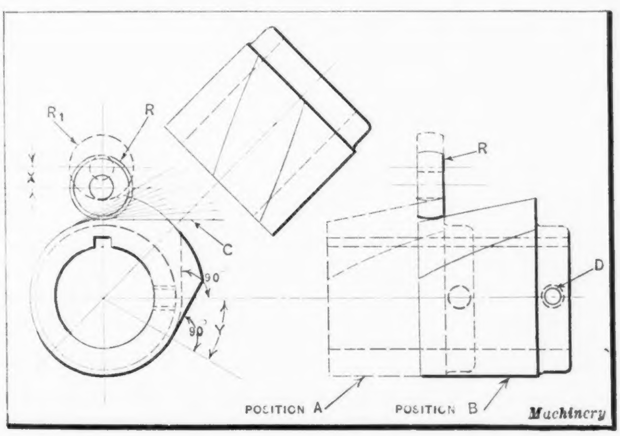


Fig. 1. Cam that is Adjustable for Early or Late Throw

in the required position by a set-screw in the tapped hole *D*. This set-screw should have a flat end as it comes in contact with a flat milled on the shaft.

In Fig. 2 is shown a cam that is adjustable for the length of dwell, one of the spiral sides being the reverse of the other. The highest position attained by the cam roller *R*, Fig. 1, is indicated by the dotted lines R_1, the rise being indicated by dimension *X*. It will be noted that the full rise is obtained by sliding the cam on the shaft from position *B* to position *A*. Lines drawn at right angles to the end of the spiral form the angle *Y* from which the lead of the spiral is calculated for the milling operation. This spiral surface should be generated by a series of tangent cuts along lines *C*, which are similar to the profile at the edge of the cam.

In order to make the surface of the spiral flat and at right angles to the axis of the cam, it is necessary to swivel the milling machine table to the angle *E*, as indicated in Fig. 3. As angle *E* depends on the lead of the cam, the diameter of the cam and the diameter of the cutter, the quickest way to obtain the correct setting of the work is to take trial cuts until the setting is such that a straightedge will show a flat machined surface when placed at right angles to the axis. One of the centers *F* of the milling machine is geared to the lead-screw, the mandrel *G* being pressed into the hole in the cam and driven by a dog.

In milling the cams, it is best to use a narrow cutter *H*, as this will remove the metal much more readily than a wide cutter. If the cam has a left-hand lead, the first cut is started on the inside so that the cam rotates away from the cutter after the cut has been taken. This prevents the cam from binding on the side of the cutter, as it would if the cuts were started from the outside. After the spiral is cut down to the correct depth, the work is indexed slightly for each cut, until it has been revolved through the angle *Y*, Fig. 1. The table is then set at right angles to the mill-

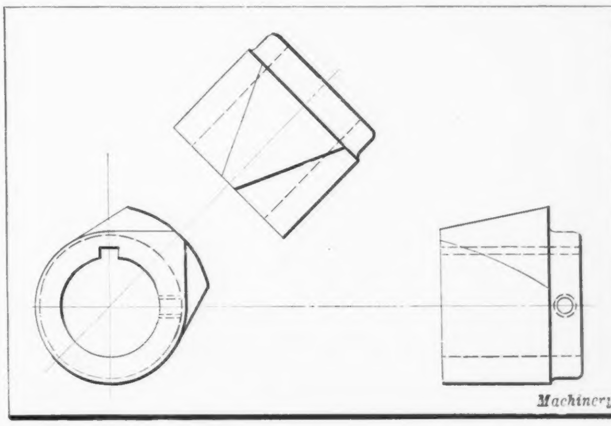


Fig. 2. Adjustable Dwell Cam

ing machine spindle and the concentric part of the cam milled by taking a series of parallel cuts, after which the cam is finished by filing.

* * *

THE GERMAN MACHINE INDUSTRY

German machinery exports declined approximately 48 per cent in 1923 as compared with 1913. The decline, by volume, is greatest in the steam locomotive field where the reduction was 68.5 per cent below the 1913 figure. Machine tool exports were reduced 45 per cent as compared with the previous ten years. Among the causes mentioned for the great decline in exports are the Ruhr occupation, whereby the supplies of iron and coal on which the machinery industry in the rest of Germany is largely dependent were cut off; and the fact that Russia, which was Germany's best customer in normal times, is no longer in a position to import. Exports have also heavily declined to the South American market which formerly was of great importance. The loss of the South American business is said to be due to successful competition from the United States.

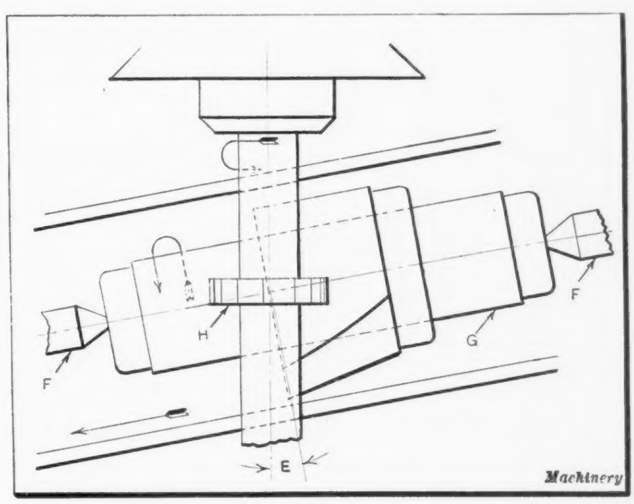


Fig. 3. Method of milling Cams shown in Figs. 1 and 2

Notes and Comment on Engineering Topics

According to recent information obtained from abroad, lumber fresh from the forest can now be used for construction, pattern, and cabinet work within three days after the timber leaves the stump, through the employment of a vacuum drying process which has recently been developed in Sweden. Experiments have shown that through this vacuum process birch wood 5 inches in diameter, after forty-eight hours of drying in vacuum, had its moisture percentage reduced to less than 10 per cent without any appreciable cracks being formed and without any weakening of the fiber. The cost of operation of the new process is estimated at approximately $1 per thousand board feet.

What is stated to be the largest and most powerful reflecting telescope in Europe has recently been constructed by the Zeiss firm of Jena, Germany, and installed in one of the principal German observatories, that of Neu-Babelsberg near Berlin. The principal mirror is slightly over four feet in diameter. There are two auxiliary mirrors used alternately, according to whether the telescope is employed either on the Newton or Cassegrain system, the focal distance being approximately 28 feet in the former case and 80 feet in the latter. The cupola surrounding the telescope is about 42 feet in internal diameter.

A new type of electric locomotive, using oil for its fuel, the first of its kind ever manufactured in America, has been built jointly by the General Electric Co. and the Ingersoll-Rand Co. This locomotive has been especially designed for switching service and will be given its first practical test by the New York Central in its freight yards in New York City. The power plant equipment consists of a 300-horsepower oil engine, direct-connected to a 200-kilowatt generator. The motive power consists of four motors, one of which is geared to each of the four axles. The unit has a total weight of 60 tons on the drivers.

Apart from the requirements for railroad transportation, the automotive industry is the largest single buyer of raw materials. In 1923 the auomotive industry used 3,470,000 tons of steel in the production of new cars, not considering the steel used in making accessories and replacement parts. Careful estimates of the value of this steel has been placed at over $300,000,000, or about 16 per cent of the total value of all the steel produced during the year. In addition to this vast quantity of steel, over 91,000,000 pounds of aluminum was used. The industry also used more than 53 per cent of the entire plate glass output of the United States, and 14 per cent of the total production of hard-wood lumber.

Plans have been developed for the building of a dam at the junction of the Murray and Mitta rivers in Australia, which will be greater than the Assouan dam on the Nile in Egypt, which is now the greatest in the world. The Australian dam was first planned for irrigation purposes only, but the project has now been extended to include the development of hydro-electric power. The artificial lake created by this dam will be the largest in the world, and the amount of water stored up will be equivalent to the covering of an area of 1,100,000 acres one foot deep. The dam will be so built that its height can be increased at a future time, if deemed advisable, to hold nearly double the amount of water that the present plans call for.

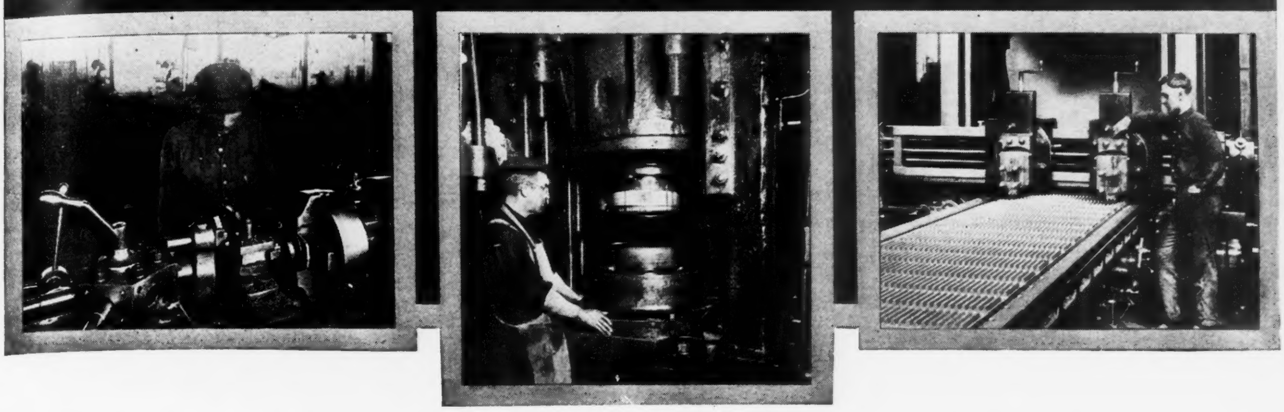
An interesting development has been made by the Vulcan Works of Hamburg, in connection with Diesel-engine driven ships. It is claimed that when a Diesel engine drives a propeller shaft through gearing in the ordinary way, the gearing is subjected to severe shocks, which it has been found impossible to eliminate even when a flexible coupling is provided. The Vulcan Works have developed a hydraulic coupling, interposed between the engine shaft and the remainder of the driving mechanism. The speed reduction is wholly effected by the gearing, and the hydraulic coupling merely serves to provide complete elasticity to the drive and prevent the shocks from the engine being transmitted to the gearing.

A table published in *Engineering*, London, of comparative rates of wages in the machine industries in different countries in 1922, shows that the average wages for machinists, based on the exchange rates in that year, were more than twice as high in the United States as in Great Britain and France, and nearly three times as high as in Belgium. Patternmakers' wages were nearly three times as high in the United States as in Great Britain, and four times as high as in Belgium. The average wages for all skilled labor in the engineering industries were about two-and-a-half times as high in the United States as in Great Britain, and three times as high as in France and Belgium. The average for unskilled labor in the same industries was nearly four times as high in the United States as in France and Belgium, and nearly three times as high as in Great Britain.

Balloon tires will probably be the cause of considerable changes in the design of automobiles. It is believed that the additional cushioning effect of the low-pressure balloon tire will make it possible to redesign the whole chassis and perhaps reduce the weight of the car. This, in turn, will produce a saving of materials which may aid in reducing automobile prices. It has also been stated that four-wheel brakes have no particular advantages when balloon tires are used, because of the better traction they afford, with consequent increased braking efficiency and reduced tendency to skid. The use of chains may be greatly curtailed, while, on the other hand, the use of snubbers and shock absorbers may be increased. The reduction of car weight may permit of smaller engines with a resulting saving in fuel consumption. Many possibilities are opened up through the use of the new type of tire.

It is estimated that there are in use today 2,500,000 radio sets in the United States, and that the making and installation of these sets has consumed 5,000,000 pounds of copper. In five years' time, it is believed, the number of radio sets will equal the number of automobiles in use in the country —that is, there will be about 15,000,000 sets. For this purpose alone, in the next five years, 5,000,000 pounds of copper will be required annually. Of the sales in the radio field, 75 per cent are parts, and 25 per cent finished sets. In 1923, the total volume of sales in the radio industry was $115,000,000. As the equipment is becoming more and more perfected, it is believed that the sales will ultimately reach $500,000,000 a year. Twenty-five per cent of all radio merchandise sales are represented by vacuum tubes. There are at present 550 broadcasting stations in this country, five of which are high-powered stations with a sending radius measured in thousands of miles.

Letters on Practical Subjects



MACHINING A TRANSMISSION HOUSING

The method of machining the transmission housing of an electric truck described in this article, may be of interest to MACHINERY'S readers who sometimes encounter work of a similar nature. The transmission housing which is shown in Figs. 1 and 2 was designed by the writer with the intention of having it machined on a boring mill. The casting for the housing was sent to the machine shop together with a production blueprint as an experimental job, with instructions that great care be taken to hold the work to the specified dimensions. As the casting was quite heavy, the overall dimensions being about 16 by 11 inches, it was naturally supposed that the work would be done on a boring mill and no instructions were given as to the type of machine that should be used.

On visiting the shop to ascertain how the work was progressing, the writer was much surprised to find the casting secured to the faceplate of a 24-inch engine lathe, the capacity of which was just sufficient to swing the work. In order to insure proper meshing of the gears, it was necessary that the bearing surfaces at *A*, *B*, and *C*, Fig. 1, be accurately bored to size and parallel with each other, as well as the exact distance apart. After being assured by the machinist that the work would be done with the required degree of accuracy, the writer became interested in the procedure followed in setting up and machining the work.

The first step in setting up the work was to put sticks or cross pieces in the rough unbored ends of the casting. Centers were next scribed on these pieces which served as guides in setting the work so that the hubs would be of an equal thickness on all sides. The casting was then clamped in place on the faceplate, as shown in Fig. 1. The bores at *A* and *B*, the ends of the hub, and the shoulders were machined with the usual types of boring and facing tools. The diameter *H* of the bore *B* was measured with inside micrometers inserted through the opening at *D*. Both dimensions *H* and *I* were made to fit the races of Timken roller bearings. After these machining operations, the work was removed from the faceplate so that the latter could be adapted to hold the work for the subsequent operations.

Next the hole *J*, Fig. 2, was drilled in the faceplate, sufficient clearance being allowed to permit the stud *D* to be adjusted to give the exact center distance between the finished roller bearing seats and the bore having a diameter represented by dimension *Q*. Then a cut was taken from the front side of the faceplate so that a button *G* was left at the center. The stud *D* with the collar *K* and the special washer *E* were carefully machined to fit the bores *A* and *B*, Fig. 1. A measuring block was next made up having the proper dimension *C*, Fig. 2, which was carefully calculated. This block was then used in locating the stud *D*, the position of which was carefully checked up by measuring the distance *B* with micrometers.

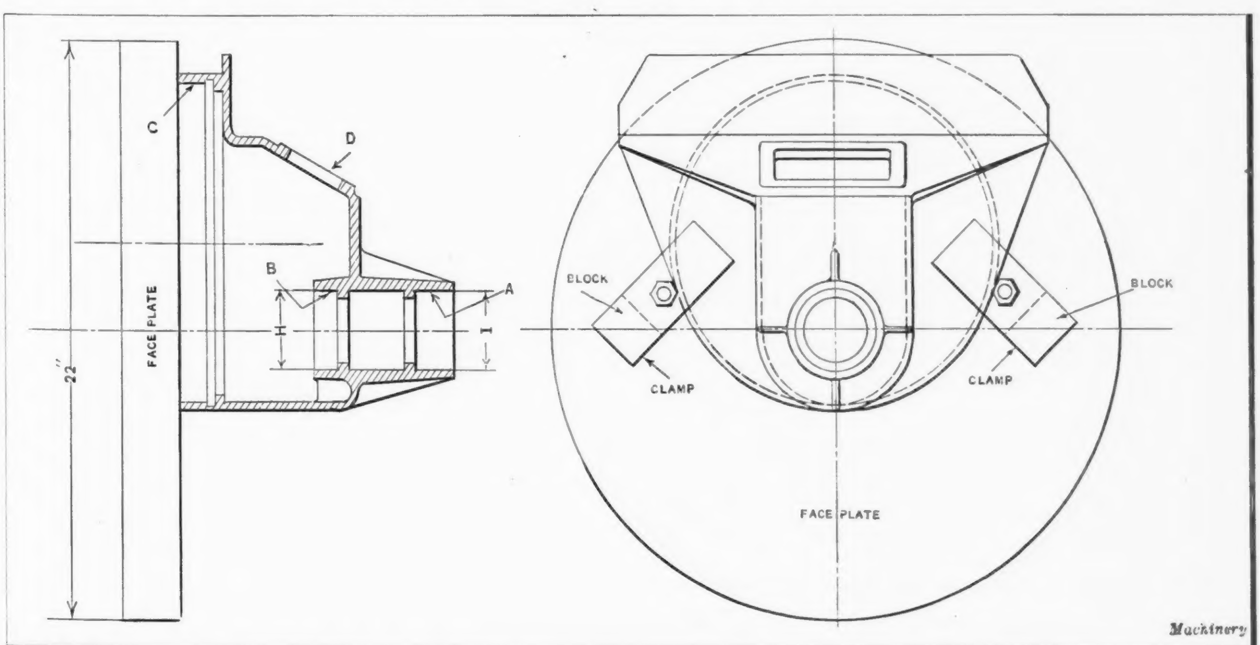


Fig. 1. Transmission Housing mounted on Faceplate for First Machining Operation

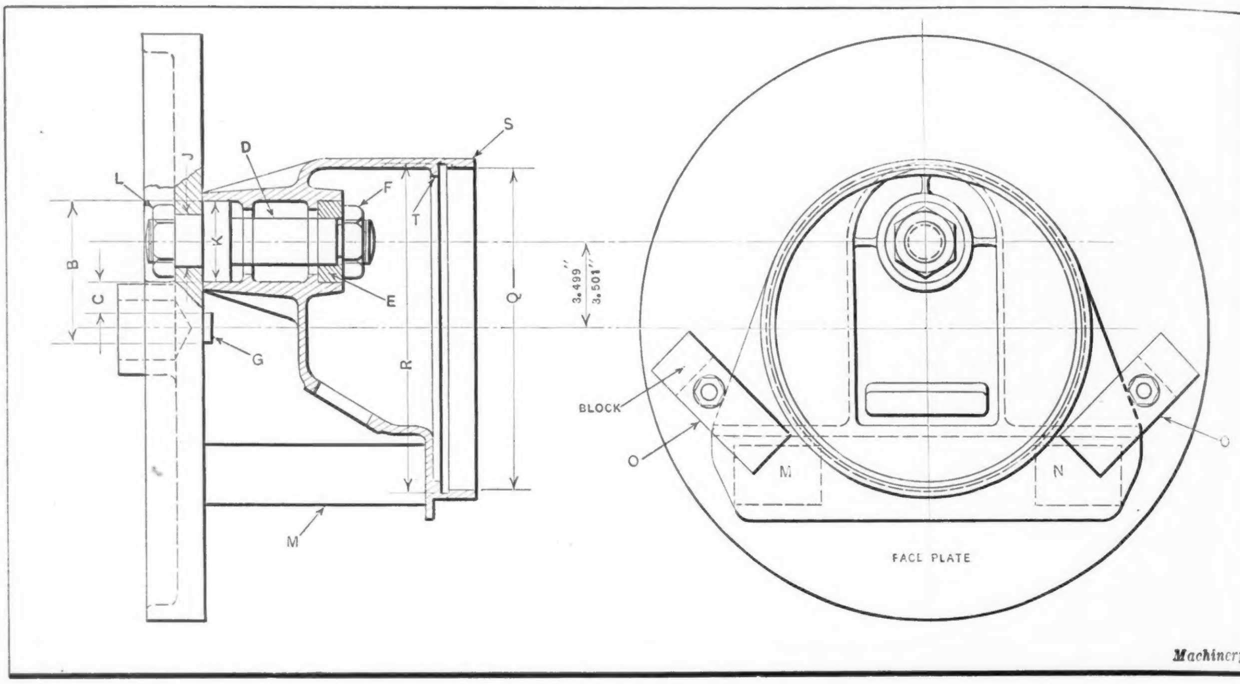


Fig. 2. Method of holding Housing for Second Machining Operation

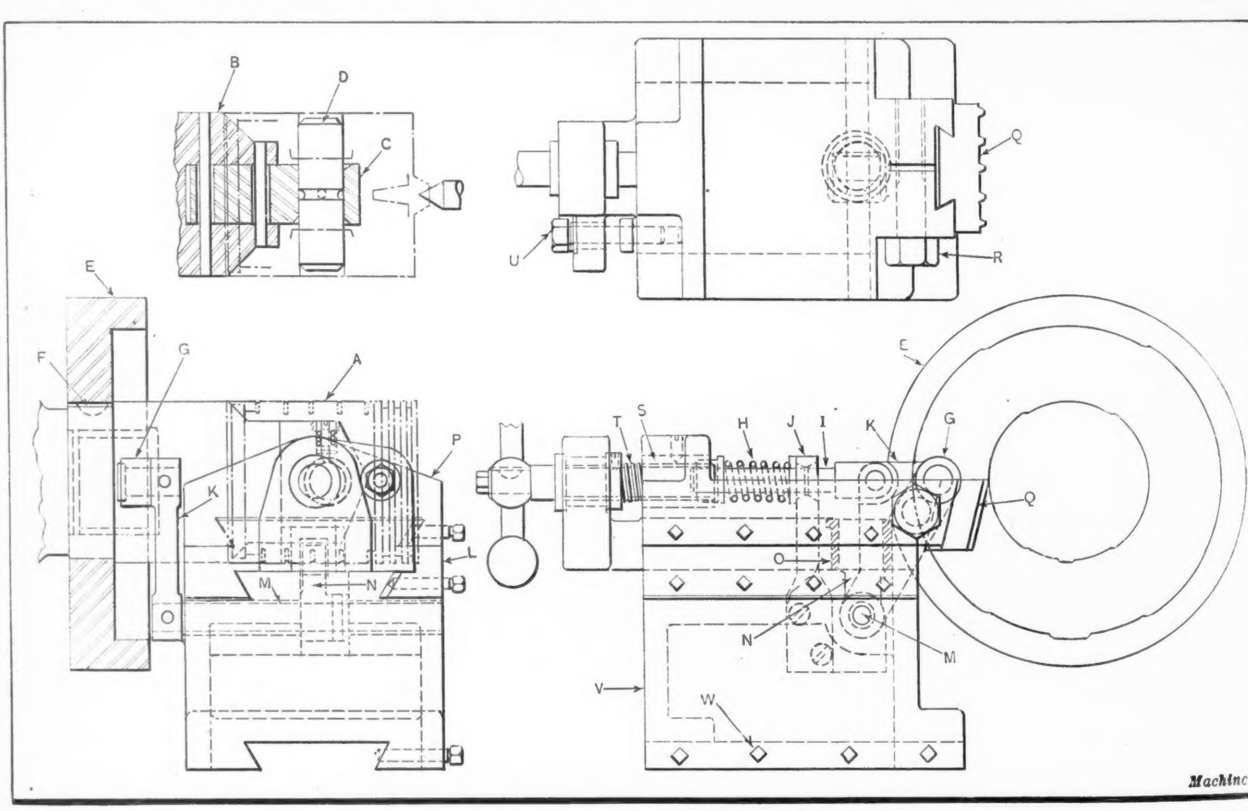
It will be noticed that blocks *M* and *N* are employed to support the overhanging side of the casting. After clamping the casting firmly in place by means of clamps *O*, the inside and end of the casting from the point indicated by *S* to the point *T* were accurately machined to size.

Roselle, N. J. W. R. GRAHAM

TURNING INTERRUPTED OIL-GROOVES IN PISTONS

The attachment shown in the accompanying illustration was built for the purpose of turning the interrupted oil-grooves in the piston shown at *A*, but it could also be adapted to cam turning, cutter relieving, or other work of a similar nature. The work-holding member consists of a large special center *B*, which is slotted to receive the floating driving member *C*; the latter, in turn, is slotted to receive the dummy wrist-pin *D* which acts as a driver. The tailstock center is of the familiar bayonet-lock construction. The controlling cam *E* is attached to the spindle nose and driven by key *F*. The cam roller *G* is held against the cam by means of spring *H*, rod *I*, and bracket *J*, and is attached to the lever *K* which operates the lower half *L* of the cross-slide. Slide *L* is operated by shaft *M* and lever *N* which operates in bushing *O*.

The feeding movement of the tool is accomplished by the upper cross-slide *P*, in which the grooving tool *Q* is held by clamp nut *R*. At the front end of slide *P* is a bronze nut *S* which engages the feed-screw *T*; the latter is prevented from moving endwise by a lug projecting from the lower slide *L*. Thus the upper slide can be advanced by turning feed-screw *T* until the stop-bolt *U* comes in contact with the



Attachment for turning Interrupted Oil-grooves in Pistons

lug on the lower slide. The required depth of cut is insured by properly adjusting the bolt *U*.

It will be noted that the construction of the fixture is such that the feeding movement is independent of the cam motion which controls the movement of the tool by operating both of the slides simultaneously as one piece. Shaft *M* runs in a stationary bearing in base *V* which is attached to the carriage by means of set-screws, one of which is shown at *W*. These set-screws permit the base of the attachment to be located any distance from the lathe center, to suit the diameter of the work. When the attachment is in use, the spindle is run at a speed of about 25 revolutions per minute. At this speed there is no tendency for the roller to jump over the high points of the cam, but if higher speeds are used, a grooved cam may be required to provide positive action of the tool-slide.

Cleveland, Ohio HERBERT W. CABLE

EQUIPPING A BORING MILL FOR CUTTING KEYWAYS

In some shops the foreman is continually confronted with special jobs that require unusual set-ups or methods of machining. The method of equipping a boring mill to handle a job of this kind is illustrated in Figs. 1 and 2. The job

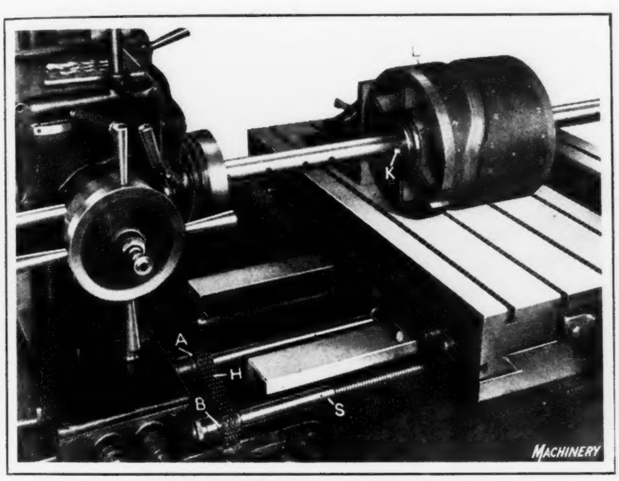


Fig. 1. Boring Mill equipped for cutting Keyway

in this case is that of cutting a keyway ½ inch wide by ¼ inch deep for the full length of the bore in the cam drum shown at *L*, Fig. 1. This cam is 12⅞ inches in diameter and 12¼ inches long. As no broaching machine or keyseater of sufficient capacity to handle this job was available, it was decided to use a boring mill.

The first step in equipping the boring mill for the keyseating job was to clamp the spindle firmly in place to prevent any circular or horizontal movement. The tool *K*, Fig. 1, was secured to the boring-bar and accurately centered in the hole in the drum. The drum was strapped firmly to the table, and the latter moved to the left for the cutting stroke. Then the tool was backed away slightly to prevent it from dragging on the return stroke, after which it was again fed in for the next chip. As the table feed-screw was not provided with a power feed, the process proved to be rather tiresome for the operator, who was obliged to turn the table feed-wheel continually. Keyways were required to be cut in a number of the drums, so it was decided to add a power feed to the table feed-screw of the boring mill.

Reference to Fig. 1 will show clearly how this was done. The location of the two shafts concerned and the center distance between them made it impossible to use a pair of gears. For this reason advantage was taken of the flexibility of a silent chain drive, which was installed as shown in the lower left-hand corner of the illustration. In calculating the length of the chain, it was found that a 50-link ⅜-inch pitch chain on two 21-tooth sprockets would be

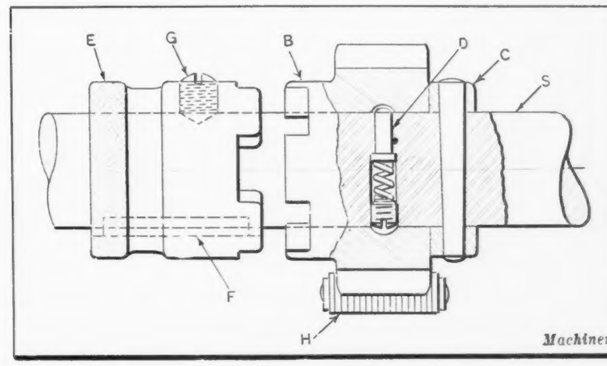


Fig. 2. Method of mounting Driven Sprocket on Feed-screw

about 0.027 inch too short. The Whitney Mfg. Co., who furnished the silent chain and sprockets, easily took care of this slight difference by running the chain under quite a heavy load until the pitch was sufficiently lengthened to allow it to be put in place without being too tight.

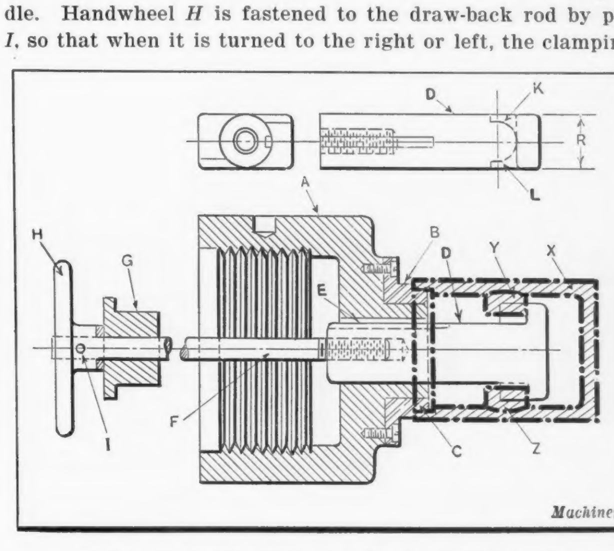
In Fig. 2 is shown the method of attaching the driven sprocket *B* to the feed-screw shaft. The driving sprocket *A*, Fig. 1, is pinned to the shaft, while the driven sprocket *B* is made a running fit on the table feed-screw shaft *S*. The collar *C*, Fig. 2, and the spring-actuated plunger *D* serve to keep sprocket *B* from moving endwise. On the projecting end or hub of sprocket *B* are clutch teeth which fit the clutch sleeve *E*. Sleeve *E* is free to slide on the shaft, and drives the latter by means of the round-end feather key *F*. When the power feed is not in use, the sliding clutch sleeve is held in place by the set-screw *G*, in order to keep it from accidentally engaging the clutch teeth on the sprocket. A chain guard of sheet metal is used when the machine is in operation to enclose the sprockets and chain *H*.

Hartford, Conn. FRANK A. THAS

FIXTURE FOR PISTON-TURNING

The fixture shown in the accompanying illustration is designed for use in turning pistons either on a lathe or a chucking machine. The adapter *A* is threaded to fit the nose of the machine spindle, and has a steel plate *B* attached to its face by means of screws. This plate locates the open end of the piston concentric with the lathe spindle. The recess at *C* is bored true with the inside of the piston, so that the piston will be properly balanced when the outside is finished.

Through the center of the adapter *A* is passed a clamping piece *D* which is keyed at *E* to the adapter, but is free to slide on it. The draw-back rod *F* is threaded to fit the tapped hole in the clamping piece *D*, and extends through the center of the machine spindle and bushing *G*, which is located at the extreme left-hand or back end of the lathe spindle. Handwheel *H* is fastened to the draw-back rod by pin *I*, so that when it is turned to the right or left, the clamping



Fixture for holding Pistons on Lathe or Chucking Machine

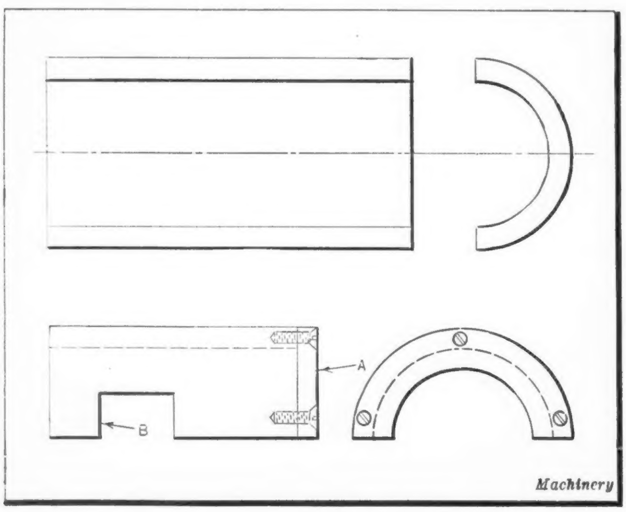
piece D is made to travel longitudinally in the piston X. Thus, by manipulating handwheel H, the piston can be clamped in place or released at the will of the operator. The hooked or T-shaped end of clamp D engages the bosses Y and Z on the inside of the piston. The inner sides of the projecting ends of piece D are shaped as shown in the two upper views in the illustration. The full line at K shows the shape of one side of the projecting end, and the dotted line at L, the shape of the other side.

When a piston is placed on the fixture, it is turned so that the bosses will pass the narrow portion of the clamping piece, indicated by the dimension R. When the end of the piston is in position on plate B, the handwheel H is turned to the right until the projecting ends of clamp D are drawn up tight against bosses Y and Z. When held in this manner, the outside of the piston can be turned with the assurance that it will be concentric with the inside. The end can be faced and the grooves for the rings cut if desired, without unclamping the work. In making a fixture of the kind described, care must be taken to have the projecting ends of the clamping piece so formed that when the work is being turned, the thrust on the cutting tool will tend to tighten the clamping piece.

M. H.

GAGES FOR TURNING SHOULDERS

If a large number of shouldered shafts are to be turned preparatory to grinding, considerable time can be saved by using gages like the one shown in the accompanying illustration for setting the turning tool so that the shoulder will be located the required distance from the end of the shaft or from another shoulder. Gages of this kind are made by turning up bushings having a loose fit over the work and then cutting or splitting these bushings along the center, thus forming two parts like the one shown in the upper view in the illustration. If the shaft is to have more than one shoulder the first cut is started at the shoulder nearest the headstock end of the shaft and the tool fed toward the tailstock. The half-bushing or gage is placed on the work to be turned and the tool brought into contact with the end of the bushing. The bushing is then removed and the tool fed in to the required depth for the first cut. If the shaft has more than one shoulder the unused half-bushing may be



Gages used in setting Tool for turning Shoulders

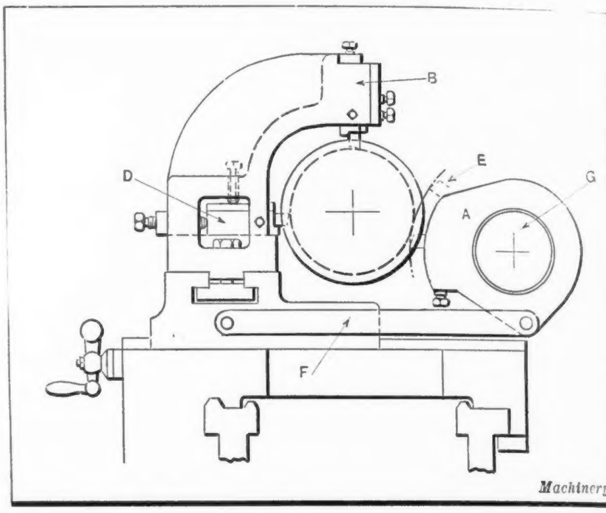
cut to the proper length for use as a guide in locating the tool for turning the second shoulder.

For shafts having only one shoulder located comparatively close to one end of the work, a bushing like the one shown in the lower view of the illustration can be used for locating the tool. The plate A, secured to the end of the bushing, is placed in contact with the end of the shaft and the surface B used as a stop, in setting the tool for facing the shoulder.

Newark, N. J. J. H. SMIT

PISTON-GROOVING ATTACHMENT

A three-tool piston-grooving lathe attachment of unusual design is shown in the accompanying illustration. The tools held in the bellcrank type of holder A take the roughing cut, those in the overhanging arm B the semi-finishing cut, and the ones in the holder D the final finishing cut. The tools in each of the three holders are of the magazine



Lathe Attachment designed for grooving Pistons

type and have as many blades as there are grooves in the pistons. When the cross-slide is at the extreme left-hand position, the tools in block A are in the position indicated by the dotted lines at E. As the cross-slide is fed inward, the link F which connects the cross-slide with the holder A causes the latter member to pivot on the fixed pin G, so that the cutters E rough out the piston-ring grooves.

The continued inward movement of the slide brings the semi-finishing cutters in holder B into contact with the work. The cutters in this holder are fed into the work tangentially so that the cut is completed when they have reached a position directly over the center of the piston. As soon as the semi-finishing tools have done their work, the finishing tools in holder D come in contact with the work and are fed straight in until the grooves have been cut to the required depth. As each successive cut widens the grooves, no drag is encountered.

Detroit, Mich. KARL F. MARX

CUTTING SHEET METAL WITH ACID

Recently, the writer saw a workman employ rather an unusual method of cutting out a piece of work from a sheet of spring steel 0.006 inch thick. The work was semicircular in outline and had four small holes at one side. It was very important that the work be kept flat. Several pieces had been made by cutting and drilling, but the pressure of the tools seemed to have a peening action on the sheet metal which caused it to warp.

Finally the workman coated a piece of the sheet metal with wax and scribed the outline of the part and the holes through the wax with a sharp pointed tool. He then applied etching acid to the metal exposed by the scribed outline. In a few minutes the acid ate its way through the metal, thus blanking out the part. The acid was then removed from the edge of the part and each of the four holes etched through separately. The part cut out in this manner was flat and satisfactory in every way.

Waltham, Mass. A. N. KING

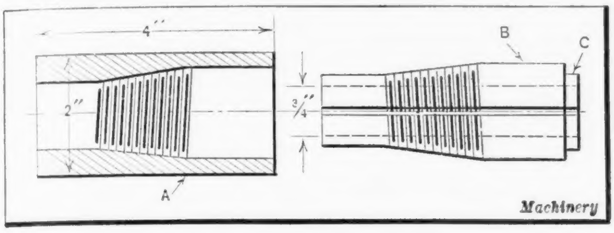
* * *

My creed: To make business less of a battle, more of a service; to replace the law of the jungle in business with the law of civilization; to use my fighting strength for this ideal rather than against my competitor.—*N. Bosch, President Western Machine Tool Works, Holland, Mich.*

Shop and Drafting-room Kinks

HOLDING PULLEY ON SHAFT

Some difficulty was experienced in keeping a steel pulley from slipping on a shaft that was smaller in the middle than at the ends. This trouble was eliminated, however, by using an expansion bushing such as shown in the accompanying illustration. The outer chamber A is machined to a good fit in the hole in the pulley, which was bored out from $\frac{3}{4}$ inch to 2 inches in diameter. The inner chamber B is machined to fit the outer chamber and a 1-inch pipe thread is cut on the middle section to fit the thread cut in the center of the outer chamber A. A slot is cut in the inner chamber B to permit it to contract and grip the shaft tightly when it is screwed into the outer shell. The end C of the inner shell is machined square to fit a $1\frac{1}{8}$-inch wrench.

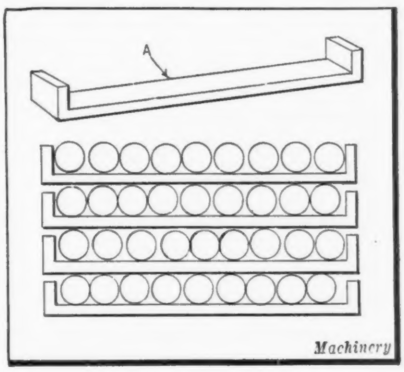


Bushing for holding Pulley on Shaft

Denver, Col. R. M. THOMAS

METHOD OF PILING SHAFTING

Accidents often occur as a result of carelessness in piling or stacking heavy shafting. A simple method of piling that will prevent accidents from rolling shafts is shown in the accompanying illustration. The pieces of flat bar iron bent up at each end, as shown at A, make it impossible for the pile to start rolling when a shaft is being removed. For ordinary transmission shafting, the bars A can be made from flat bar stock, $\frac{3}{4}$ inch thick by 2 inches wide. Three or more of these pieces may be used under each tier, depending on the length and weight of the shafting.



Method of stacking Shafting

Springfield, Vt. H. L. WHEELER

PRESS ROOM KINK

In most factories where forming and drawing operations are performed on sheet metal, it is customary to oil the blanks either by dipping them in oil or rubbing them with an oil-soaked rag. These methods are not very economical, however, as they leave more oil on the blanks than is required for satisfactory results. The method of oiling the blanks described in this article is employed in one of the punch press departments of a large factory with very satisfactory results, and undoubtedly can be employed to advantage in other factories. The oiling device was made from an old electric washing machine having a wringer attachment. A gallon can was placed directly over the wringer rolls to serve as a container for the oil, and a valve was soldered to the bottom of this can. Then a table was built and set just at the front of the wringer rolls.

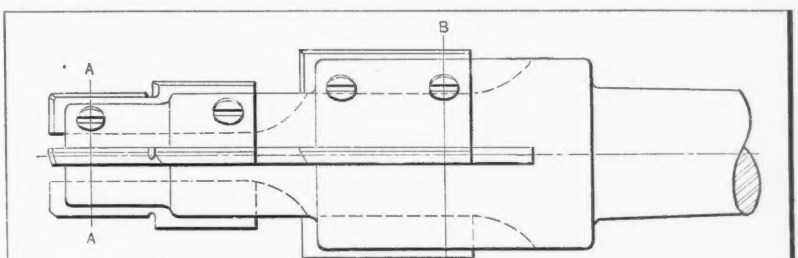
To oil the blanks, the valve in the gallon can is opened, allowing a supply of oil to fall on the wringer rolls. The oil spreads out on the rolls and drains off into the tank, where it is collected and used over again. The blanks to be oiled are fed through the rolls of the wringing machine and allowed to fall on the table. With this arrangement, both sides of the blank receive a thin coating of oil. After a supply of blanks has been oiled for one punch press, the oiling device is moved along to another press. As the rolls through which the blanks are fed are only 11 inches long, the device is limited to the oiling of comparatively small blanks. A similar device having longer rolls could, of course, be constructed and used for oiling blanks of any size.

Cicero, Ill. JOHN J. BORKENHAGEN

SECURING INSERTED BLADES IN REAMERS

An efficient method of securing inserted blades in reamers and taps when the spacing is far enough apart to permit its use is shown in the accompanying illustration. After the reamer body X has been turned to size, seats are milled or bored to a slightly larger radius than the clamping pieces, one of which is shown at Y. The clamping pieces are then secured to the body of the reamer, a spacing liner being placed underneath the piece to obtain a clearance D. The slots for the cutters are next milled out, the stock being removed from the body of the holder as well as from the clamping pieces Y. After the liners or spacing pieces have been removed, the cutters can be inserted and securely clamped in place, even though they may vary greatly in thickness. The section in the lower right-hand corner of the illustration shows the arrangement of the clamping pieces when six blades are employed.

U. S. Navy Yard, Mare Island, Cal. F. H. SOVEREIGN



Method of securing Inserted Blades in Reamers

Questions and Answers

LEAD-COATING STAMPINGS

A. H. H.—What is the most economical method of lead-coating small articles made from hot-rolled strip? After punching, the parts are pickled, dipped in a flux, and then immersed in hot metal consisting of two parts lead to one part tin. We cannot get a clean finish, because the scum from the top of the metal adheres to the articles.

ANSWERED BY W. W. T.

If about 1/2 inch of powdered charcoal is kept on top of the melted lead and the stampings are plunged through the charcoal, the scum will not interfere with the lead coating.

WHAT DOES "JOINT INVENTORS" MEAN?

F. H. C.—Will you be good enough to tell me just what is meant by the term "joint inventors"? I have developed what seems to be a valuable improvement in automobiles, but have not sufficient funds to finance an application for patent, and the making of experimental devices. An acquaintance of mine is willing to furnish the required capital, but wishes to join with me in the application for patent. It is my contention that this is not the proper procedure, inasmuch as he has taken no part in the invention itself.

ANSWERED BY GLENN B. HARRIS, YONKERS, N.Y.

The term "joint inventors" is one that has been more or less misunderstood, not only by inventors, but also by others interested in patents, since the inception of our patent system. A person who furnishes capital only is in no sense a joint inventor, and his interest in the invention and the patent to be obtained therefor should be conveyed by an assignment executed in due form.

To make clear the meaning of "joint inventors" reference will be made to the automobile. Should you, in collaboration with another, devise an engine for automobiles, both working on this particular part of the machine, and one making a suggestion here and the other there, a joint inventorship would exist. On the other hand, were you to design the motor, and your co-worker the transmission or the differential, there would not be a joint inventorship, for the reason that the motor could operate independently of the particular type of transmission employed, and, vice versa, the transmission could operate independently of the engine. It may be further observed that joint inventors are not entitled to, nor can they obtain, separate patents.

SUPER POWER

A. L.—As the term "super-power" is being used frequently in the technical press, please explain the general meaning of this term and in what way the super-power development differs from present-day methods of power generation and distribution.

A.—The term "super-power" relates to developments tending toward more economical methods of generating and distributing power. An increasing number of water power plants and steam plants of large sizes are being developed, and because of certain economic advantages with which all engineers are familiar, the present tendency is to connect groups of power plants, forming large composite systems. By its very nature a composite system can produce power at a lower cost than an isolated local company. It is assumed, therefore, that the growth of these composite systems will continue until eventually a few "super-power" systems, drawing upon all economical sources of power within the area they cover, will supply electric energy to large territories. Even well equipped local companies doubtless will join the super-power systems, because they will then be able to turn their surplus power into the common reservoir for general use and can draw from the same reservoir such additional power as they may require for use in the case of emergencies.

It is expected that this widely distributed and economical supply of electrical energy which will thus be furnished by the super-power systems, will result in numerous benefits, such as improved transportation; reduction in the cost of manufactured products; promotion of mining and metallurgical operations; increased effectiveness of human labor; and conservation of the diminishing fuel resources.

UNILATERAL AND BILATERAL TOLERANCES

J. C. F.—What is meant by the expressions "unilateral tolerance" and "bilateral tolerance," and in what way, if any, do these methods of designating tolerances on drawings, differ from those in common use?

A.—The term "unilateral tolerance" means that the total tolerance, as related to a basic dimension, is in *one* direction only. For example, if the basic dimension were 1 inch and the tolerance were expressed as $1.00 - 0.002$, or as $1.00 + 0.002$, these would be unilateral tolerances, since the total tolerance in each case is in one direction. On the contrary, if the tolerance were divided, so as to be partly plus and partly minus, it would be classed as "bilateral." Thus, $1.00 {+0.001 \atop -0.001}$ is an example of bilateral tolerance, because the total tolerance of 0.002 is given in two directions—plus and minus.

The special committee of the Society of Automotive Engineers that has to do with methods of expressing limits and tolerances advocates the following general rule for dimensioning: The initial dimensions placed upon component drawings should be the exact dimensions that would be used if it were possible to work without tolerances. Tolerances should be given in that direction in which variations will be the least objectionable. When the effect of variations is the same in one direction as in the other, the tolerances should be an equal amount in both directions, or bilateral.

CARBURIZE OR CARBONIZE?

R. S. T.—Will you kindly inform me which is the correct term to use—"carburize" or "carbonize" when referring to the impregnation of steel with carbon; as in the casehardening process?

A.—The two words "carburize" and "carbonize" are frequently used interchangeably to designate the process of impregnating the surface of steel with carbon in order to raise the carbon content of low-carbon steel so that it may be hardened by heating to the hardening temperature and quenching in oil, brine, or water. "Carburize," however, is the correct term to use, and while the other term has been so generally employed that it is now given in dictionaries as an allowable word, its use should be discouraged. Webster's New International Dictionary defines "carburize" as "to combine or impregnate with carbon; as, to carburize iron by cementation." The word "carbonize," again, is defined as "to convert into a residue of carbon by the action of fire or some corrosive agent; to char." As a secondary definition, it is given as equivalent to "carburize." The proper meaning of "carbonize," however, is the converting of a substance into carbon; for example, a carbon lamp filament is carbonized when the fiber from which it is made is charred.

Gear Designing Tables

By L. S. BURBANK

A SIMPLE and direct method of determining the relation between the pitch and power-transmitting capacity of either spur gearing or bevel gearing is provided by means of the accompanying tables, which cover all ordinary conditions. Table 1 gives the diametral pitch and the power-transmitting capacity for a given pitch-line load and velocity. This table is based upon the Lewis formula, and applies to a cast-iron gear having a 14½-degree pressure angle. As the number of teeth in a gear affects its strength, a strength factor y of 0.10 was used as a basis for Table 1, this being the factor for twenty-seven teeth in a table arranged for circular pitch; hence, the "preliminary" diametral pitch given in Table 1 applies to twenty-seven teeth.

This first table is accompanied by three others containing factors that are used whenever necessary for modifying the figures obtained from Table 1, in order to compensate for differences due either to tooth number, tooth number and pressure angle, or the use of a material other than cast iron. The conversion of the data in Table 1 to the designing of bevel gears is also provided for by a separate table.

The results given in Table 1 may be used safely for all tooth numbers above twenty-seven and also for a few numbers less, assuming that the gear is of cast iron. If the given tooth number is to be taken into account, then the diametral pitch obtained from Table 1 is multiplied by a factor found in Table 2; furthermore, if the material is

TABLE 1. DIAMETRAL PITCH (D. P.) AND HORSEPOWER (H. P.) FOR GIVEN VELOCITY AND LOAD*

Velocity at Pitch Line, Feet Per Minute	TANGENTIAL LOAD AT PITCH LINE, IN POUNDS																	
	3		5		7.5		10		15		25		35		50		75	
	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.
2400	38	0.22	29	0.36	24	0.55	20	0.73	17	1.10	13	1.80	11	2.50	9	3.60	8	5.50
2000	39	0.20	30	0.30	24	0.45	21	0.61	17	0.91	13	1.50	11	2.10	9	3.00	8	4.50
1800	40	0.16	31	0.27	25	0.41	22	0.55	18	0.82	14	1.40	12	1.90	10	2.70	8	4.10
1500	42	0.135	32	0.23	26	0.34	22	0.45	19	0.68	14	1.10	12	1.60	10	2.30	8	3.40
1200	45	0.110	35	0.18	28	0.27	25	0.35	20	0.55	16	0.90	13	1.30	11	1.80	9	2.70
1000	48	0.091	37	0.15	30	0.22	26	0.30	22	0.45	17	0.75	14	1.10	12	1.50	10	2.20
800	52	0.073	40	0.12	33	0.18	28	0.24	23	0.36	18	0.60	15	0.80	13	1.20	10	1.80
600	56	0.055	44	0.09	36	0.13	31	0.18	25	0.27	20	0.45	16	0.60	14	0.90	11	1.40
500	59	0.045	46	0.07	36	0.11	32	0.15	26	0.23	20	0.38	17	0.52	14	0.75	12	1.10
400	62	0.036	48	0.06	37	0.09	34	0.12	28	0.18	21	0.30	18	0.42	15	0.60	12	0.90
300	66	0.027	51	0.05	41	0.07	36	0.09	29	0.14	23	0.23	19	0.32	16	0.45	13	0.70
250	67	0.022	52	0.04	42	0.06	37	0.07	30	0.11	23	0.20	20	0.26	16	0.38	13	0.57
200	71	0.018	55	0.03	45	0.05	39	0.06	32	0.09	24	0.15	20	0.21	17	0.30	14	0.45
150	74	0.013	57	0.023	47	0.03	40	0.04	33	0.07	26	0.11	22	0.16	18	0.23	15	0.34
100	82	0.01	63	0.015	52	0.02	45	0.03	37	0.04	28	0.07	24	0.10	20	0.15	16	0.23
75	82	......	63	0.012	52	0.017	45	0.02	37	0.03	28	0.06	24	0.08	20	0.11	16	0.17
50	82	......	63	......	52	0.01	45	0.01	37	0.02	28	0.03	24	0.05	20	0.07	16	0.11
35	82	......	63	......	52	......	45	......	37	0.01	28	0.02	24	0.03	20	0.05	16	0.08
25	82	......	63	......	52	......	45	......	37	0.01	28	0.02	24	0.02	20	0.04	16	0.06
20	82	......	63	......	52	......	45	......	37	......	28	0.01	24	0.02	20	0.03	16	0.04
15	82	......	63	......	52	......	45	......	37	......	28	......	24	0.01	20	0.02	16	0.03
10	82	......	63	......	52	......	45	......	37	......	28	......	24	......	20	0.01	16	0.02
6	82	......	63	......	52	......	45	......	37	......	28	......	24	......	20	......	16	0.01

Velocity at Pitch Line, Feet Per Minute	TANGENTIAL LOAD AT PITCH LINE, IN POUNDS																	
	100		150		200		250		300		400		500		750		1000	
	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.	D. P.	H. P.
2400	6	7.20	5	11.00	5	14.50	4	18.00	4	21.80	3	29.00	3	36.00	2	55.00	2	73.00
2000	7	6.00	5	9.10	5	12.00	4	15.00	4	18.00	3	24.00	3	30.00	2	45.00	2	60.00
1800	7	5.50	6	8.20	5	11.00	4	13.60	4	16.00	3	22.00	3	27.00	3	41.00	2	55.00
1500	7	4.50	6	6.90	5	9.00	5	11.40	4	13.80	4	18.00	3	23.00	3	34.00	2	45.00
1200	8	3.60	6	5.50	6	7.30	5	9.10	4	11.00	4	14.00	3	18.00	3	27.00	2	36.00
1000	8	3.00	7	4.50	6	6.10	5	7.50	5	9.10	4	12.00	4	15.00	3	22.00	3	30.00
800	9	2.40	7	3.60	6	4.80	6	6.10	5	7.30	5	9.70	4	12.00	3	18.00	3	24.00
600	10	1.80	8	2.70	7	3.60	6	4.50	5	5.50	5	7.30	4	9.10	4	13.00	3	18.00
500	10	1.50	8	2.30	7	3.00	6	3.80	6	4.50	5	6.00	5	7.50	4	11.00	3	15.00
400	11	1.20	9	1.80	8	2.40	7	3.00	6	3.60	5	4.80	5	6.00	4	9.10	3	12.00
300	11	0.90	9	1.40	8	1.80	7	2.30	6	2.90	6	3.60	5	4.50	4	6.80	4	9.10
250	12	0.75	9	1.10	8	1.50	7	1.90	7	2.30	6	3.00	5	3.80	4	5.70	4	7.60
200	12	0.61	10	0.91	9	1.20	8	1.50	7	1.80	6	2.40	5	3.00	4	4.50	4	6.10
150	13	0.45	10	0.68	9	0.91	8	1.10	7	1.30	6	1.80	6	2.30	5	3.40	4	4.50
100	14	0.30	12	0.45	10	0.61	9	0.75	8	0.90	7	1.20	6	1.50	5	2.30	4	3.00
75	14	0.23	12	0.34	10	0.45	9	0.57	8	0.68	7	0.91	6	1.10	5	1.70	4	2.30
50	14	0.15	12	0.23	10	0.30	9	0.38	8	0.45	7	0.60	6	0.76	5	1.10	4	1.50
35	14	0.11	12	0.16	10	0.21	9	0.26	8	0.32	7	0.42	6	0.53	5	0.80	4	1.10
25	14	0.07	12	0.11	10	0.15	9	0.19	8	0.23	7	0.30	6	0.38	5	0.57	4	0.76
20	14	0.06	12	0.09	10	0.12	9	0.15	8	0.18	7	0.24	6	0.30	5	0.45	4	0.61
15	14	0.04	12	0.07	10	0.09	9	0.11	8	0.13	7	0.18	6	0.23	5	0.34	4	0.45
10	14	0.03	12	0.04	10	0.06	9	0.07	8	0.09	7	0.12	6	0.15	5	0.23	4	0.30
6	14	0.02	12	0.03	10	0.04	9	0.05	8	0.05	7	0.07	6	0.09	5	0.14	4	0.18

Machinery

* This table is based upon the Lewis formula and applies to a cast-iron spur gear having a strength factor (y) of 0.10 which is equivalent to 27 teeth. For other tooth numbers and materials use modifying factors found in Tables 2 and 4.

TABLE 2. FACTORS FOR USE WITH TABLE 1

Multiply the diametral pitch found in Table 1, by the factor below corresponding to the tooth number and style of tooth.

No. of Teeth	Strength Factors		No. of Teeth	Strength Factors	
	20° Involute	14½° Involute and Cycloidal		20° Involute	14½° Involute and Cycloidal
12	0.89	0.82	27	1.05	1.00
13	0.91	0.84	30	1.07	1.01
14	0.94	0.85	34	1.09	1.02
15	0.96	0.86	38	1.11	1.03
16	0.97	0.88	43	1.12	1.05
17	0.98	0.89	50	1.14	1.06
18	0.99	0.91	60	1.16	1.07
19	1.00	0.93	75	1.17	1.08
20	1.01	0.95	100	1.19	1.08
21	1.02	0.96	150	1.21	1.09
23	1.03	0.97	300	1.22	1.10
25	1.04	0.98	Rack	1.24	1.11

Machinery

other than cast iron, a second modifying factor is obtained from Table 4. Specific examples will now be given to show exactly how these tables are applied in practice. It is assumed throughout that the face width bears a constant relation to the diametral pitch, and is equal to 8 ÷ diametral pitch.

Example 1—What is the diametral pitch and face width of a pair of cast-iron gears having a 14½-degree pressure angle, assuming that the working load at the pitch line is 250 pounds and the pitch-line velocity 500 feet per minute? One of the gears is to have 16 teeth.

Table 1 shows that 6 diametral pitch would be required for this pitch-line load and velocity in the case of a gear having 27 teeth. However, since the required number of teeth is 16, factor 0.88 corresponding to this tooth number is taken from Table 2. The diametral pitch, therefore, equals 6 × 0.88 = 5.28, or say 5 diametral pitch. The face width equals 8 ÷ 5 = 1 3/5 inches.

It will be noted from Table 1 that 3.8 horsepower may be transmitted safely by a gear of 6 diametral pitch when the speed and load correspond to the figures given in Example 1. Now, if other gears follow in the same train and if either the speed ratio or working load is known, Table 1 may again be used. For instance, if the ratio is 3 to 1, the tooth velocity will be increased from 500 to 1500 feet per minute. Referring now to the table, we find that the horsepower in line with a velocity of 1500 feet per minute and nearest to 3.8 is 3.4 (see upper section of the table). The diametral pitch corresponding to 3.4 is 8, and the face width 8 ÷ 8 = 1 inch.

Example 2—Determine the diametral pitch for a 12-tooth 20-degree cast-steel pinion, assuming that the pitch-line load is 100 pounds and the velocity 150 feet per minute.

In Table 1 the preliminary pitch is found to be 13. The strength factor in Table 2 for 12 teeth having a 20-degree pressure angle is 0.89, and in Table 4 the material factor for cast steel and a velocity of 150 feet per minute is 1.58; hence, the diametral pitch in this case is equal to 13 × 0.89 × 1.58 = 18.2, or say 18 diametral pitch. The face width equals 8 ÷ 18, or approximately ½ inch.

Example 3—What is the proper pitch for transmitting 6 horsepower with a pair of miter gears, assuming that one gear is to be rawhide, maximum pitch diameter 6 inches, minimum pitch diameter 4 inches, speed 500 revolutions per minute, and pressure angle 20 degrees?

The pitch-line velocity in this case is about 800 feet per minute. By referring to the horsepower figures in Table 1, in line with a velocity of 800, it will be seen that 6.1 is the nearest value to the given power transmitting capacity, and the equivalent diametral pitch is 6. In Table 4 the material factor for rawhide (following General Electric Co.'s practice) is about 0.93 for a velocity of 800 feet per minute, this value being obtained by interpolation. The ratio of the maximum and minimum pitch diameters is equal to 6/4 or 1.5. Opposite this ratio in Table 3 is the bevel gear factor of 0.838. The diametral pitch, therefore, is equal to 6 × 0.93 × 0.838 = 4.68; hence a diametral pitch of 4 will be on the safe side, and the face width equals 8 ÷ 4 = 2 inches. Since the pitch diameter is 6 inches and the diametral pitch 4, the miter gears will have 24 teeth. The strength factor in Table 2 equivalent to 24 teeth will be 1.035, which is not sufficient in this case to change the pitch.

As the calculations for these tables were made by slide-rule, the last figures in the tables may not tally absolutely with closer calculation. The slide-rule method, however, is sufficiently accurate, because finally, as in the preceding example, the choice must lie between two diametral pitch values which differ by a unit or more. Odd pitches, such as 13, 15, etc., have been included in Table 1, in order to keep the values as near the theoretically correct ones as possible, until the final choice of value is made. It is believed that these tables will considerably simplify the work of designing gears, and at the same time give results that conform to recognized practice.

* * *

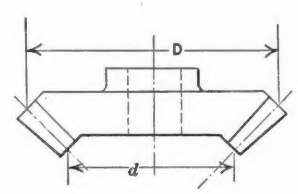
NEW IDEAS ON ENGINEERING EDUCATION

In a recent address, President Farrand, of Cornell University, quoted a prominent engineer on the subject of engineering education, as follows: "I would take the young students and give them four years of physics and four years of chemistry and enough mathematics to understand their physics and chemistry; and I would give them English, history, and economics, and psychology, and philosophy, and languages, but I would waste no time on what we call technical engineering."

This is an extreme opinion and probably few engineers would be willing to fully endorse it, but it is none the less significant as the radical thought on engineering education. The engineer quoted believes that we need educated men who are well grounded in fundamental principles, and who have resourcefulness and flexibility of mind, so that they can cope with the needs of a swiftly changing situation in the engineering field. He does not think it necessary that the engineering school should make the student experienced in the detail processes of the industry; that he leaves for the industry itself to do. However, industry itself can seldom convey this training to the young man in the logical and complete manner that the school can. Doubtless, however, much of the specialized training in engineering schools is wasted, as it is of little direct value in later life.

TABLE 3. FACTORS FOR BEVEL GEARS

Multiply the diametral pitch found in Table 1 by the factor below opposite the nearest ratio $\frac{D}{d}$



$\frac{D}{d}$	Factor	$\frac{D}{d}$	Factor	$\frac{D}{d}$	Factor
1.00	1.000	1.35	0.874	1.70	0.803
1.05	0.983	1.40	0.860	1.75	0.796
1.10	0.954	1.45	0.850	1.80	0.789
1.15	0.935	1.50	0.838	1.85	0.782
1.20	0.920	1.55	0.828	1.90	0.775
1.25	0.902	1.60	0.820	1.95	0.770
1.30	0.889	1.65	0.811	2.00	0.763

Machinery

MACHINE TOOLS AT THE BRITISH OLYMPIA EXHIBITION

A few of the machine tools shown at the recent exhibition at Olympia, London, may prove of interest to American readers. One of the machines that attracted attention was a multiple-spindle automatic made by Thomas Ryder & Son, Ltd., Bolton. This machine handles work up to 4 inches in diameter by 6 inches in length; there are five tool stations, and six work-spindles, one of the latter always being at the loading station. Indexing from one station to the next occupies fifteen seconds. The machine differs from previous designs of this class in the provision of a tool-slide on each side of the machine, in addition to the tools carried by the vertical slide on the central pillar. The machine is especially intended for continuous production of castings or forgings requiring boring, turning, and facing operations.

Another new machine of note was the side-head boring and turning mill of Webster & Bennett, Ltd., Coventry, which is built with either a 36- or a 42-inch table. An important feature is the main frame casting, the full section of which is extended sideways for the purpose of carrying the side head. John Lang & Sons, Ltd., Johnstone, showed a 17-inch screw-cutting lathe, in which the principle of centralized control from the saddle apron has been incorporated. Drop-out worms operated from the apron engage and disengage the self-acting sliding and facing motions. The same features were also seen in a 13-inch all-geared-head lathe. Messrs. Lang's latest development in facing and boring lathes is a 60-inch machine; two unique features, a patented variable-speed drive and a patented automatic speed-changing mechanism, are incorporated. With these in operation, when facing such work as faceplates or cylinder covers, the speed of the spindle automatically increases as the diameter being faced becomes smaller.

Alfred Herbert, Ltd., Coventry, showed a 6-foot 6-inch radial drilling machine that has several distinguishing features. The driving motor is reversible and is mounted on the arm which is extended—counterbalance fashion—behind the pillar, the motor balancing to some extent the weight of the arm at the operating end. The arm is of circular pipe section, and the spindle carriage carries all the controls, including that for locking the arm, so that the operator need not move from his ordinary position. The load of the carriage is taken on rollers, this feature adding considerably to the ease of handling.

Another important new design exhibited was an automatic spur gear hobbing machine by J. Parkinson & Son, Shipley. This is essentially a production machine, and its upper gear size limits are a diameter of 6 inches, face width 5 inches, and teeth of 5 diametral pitch. The machine is very compact, and one operator can attend to ten or more machines, since the time required to change from one set of blanks to another is only twenty seconds. Both hob- and work-spindles are horizontal. The latter is under the former, the work-spindle being controlled endwise by a spring-loaded cam that makes one revolution for each set of blanks. Push-buttons start and stop the machine, and a red signal lamp lights when the machine stops.

* * *

AMERICAN MANAGEMENT ASSOCIATION

The American Management Association held a conference at the New Ocean House, Swampscott, Mass., September 19 and 20. During the conference the following subjects were dealt with: "Cost of Personnel Activities," covering a survey of a large number of Massachusetts companies; and "Measuring the Effectiveness of Specific Personnel Projects." It was announced in connection with the meeting that the conference of the production executives' division of the American Management Association will hold a meeting in Cleveland about the middle of November on Administration of Employe Representation Plans. The office executives' division will hold a two-day conference, probably in New York, early in December; one of the days will be devoted to office management topics, and the other to the report on salary administration which is now nearing completion. The office of the association is at 20 Vesey St., New York City.

TABLE 4. FACTORS FOR DIFFERENT MATERIALS

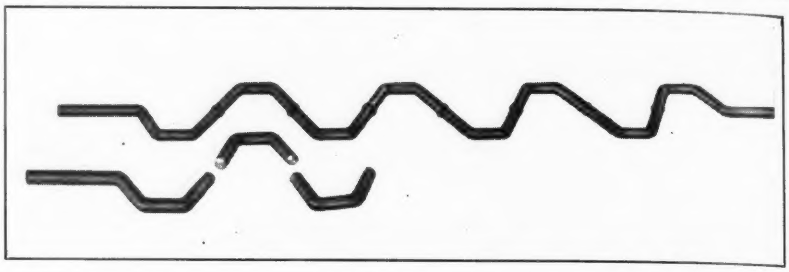
For materials other than cast iron, multiply the diametral pitch found in Table 1, by the factor below, corresponding to the material and given velocity.

Pitch-line velocity, feet per minute	100	200	300	600	900	1200	1800	2400
Cast iron, stress, pounds per square inch	8000	6000	4800	4000	3000	2400	2000	1700
Factor	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Forged steel, stress, pounds per square inch	25,000	20,000	16,000	13,000	10,000	7500	6300	5400
Factor	1.77	1.82	1.82	1.80	1.82	1.77	1.77	1.78
Cast steel, stress, pounds per square inch	20,000	15,000	12,000	10,000	7500	6000	5000	4300
Factor	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.59
Bronze, stress, pounds per square inch	12,000	9000	7000	6000	4500	3600	3000	2500
Factor	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.21
Rawhide, stress, pounds per square inch	5000	4000	3000	2500	2000	1600	1200	....
Factor	0.79	0.817	0.79	0.79	0.817	0.817	0.775	....
Rawhide, G. E. Co.'s practice	....	3600	3500	3100	2700	2400	1900	....
Factor	....	0.775	0.85	0.88	0.95	1.00	0.975	....

Machinery

Butt-welding Multi-throw Cranks

By A. M. LOUNT, Master Mechanic
Massey Harris Co., Ltd.,
Toronto, Canada



MANUFACTURERS of machinery who utilize multi-throw cranks realize the expense involved in making dies to produce these parts. Single-throw cranks are simple pieces to produce, but a double-throw crank presents more than twice the difficulty, and each additional throw adds more than its percentage of trouble and expense. Therefore, an eight- or ten-throw crank presents a problem embodying numerous difficulties and considerable expense.

Considering for a moment, making the shaker crank shown in the heading illustration, we have conditions to meet that are peculiar to this type of crank. Supported only at the extreme ends, it must be stiff enough to perform its work without undue deflection. The fact that its carbon content is only 0.25 per cent is no material assistance in this regard. Running at a moderate speed, its balance, while not necessarily absolute, must be reasonably maintained. As it is only 1 3/16 inches in diameter and 8 feet long, it will not readily hold its heat in forging, which makes it necessary to raise the initial temperature to a dangerously high point. Owing to a somewhat limited requirement and the necessity of making both eight- and ten-throw cranks, the die cost becomes a most important factor. Finally, because of the stiffness required, it is necessary to have all corners well filled out. The V-shaped construction of the throws makes this a much more difficult proposition than would at first appear.

To make bulldozer dies that will produce both eight- and ten-throw cranks of this type would probably cost about \$10,000. Hammer dies would cost more, and in the plant where the writer is employed would be out of the question, for there is no hammer large enough to handle dies of the size that these would need to be. However, there are several small board drop-hammers and an electric butt welder capable of welding 2.4 square inches of steel. These machines are used to produce cranks of the sort mentioned at a low toolage and production cost. In the following will be described the methods used to produce such cranks with a toolage cost of less than \$2000.

Sequence of Operations

Referring again to the heading illustration, it will be seen that a complete crank and three pieces of a second crank are shown. The completed crank is a welded assembly of small pieces similar to those shown. An eight-throw crank requires two end sections and six center sections, the end sections being alike and also all center sections. Five operations are performed to produce these sections, the operations being performed in the following sequence:

1. Cut off stock to length on a standard bar shear.
2. As a preliminary step, bulldoze-bend the end sections.
3. Drop-forge the end and center sections in a 750-pound board drop-hammer used in connection with a special furnace provided with a water-cooled front and back. This special furnace heats the center of the bar only, leaving the ends cool to aid in filling out the corners of the bends. No trimming operation is necessary with this forging step.
4. Tumble to remove scale.
5. Round the ends to insure a center contact in the welding operation. This end-finishing step is performed on an upright drilling machine, with the work held in a vise on the machine table. A box-tool with a hardened steel pilot bushing is first threaded over the end of the piece to be machined. This bushing holds the work in line while the cutter of the box-tool removes sufficient stock to form an arc 1/16 inch high.

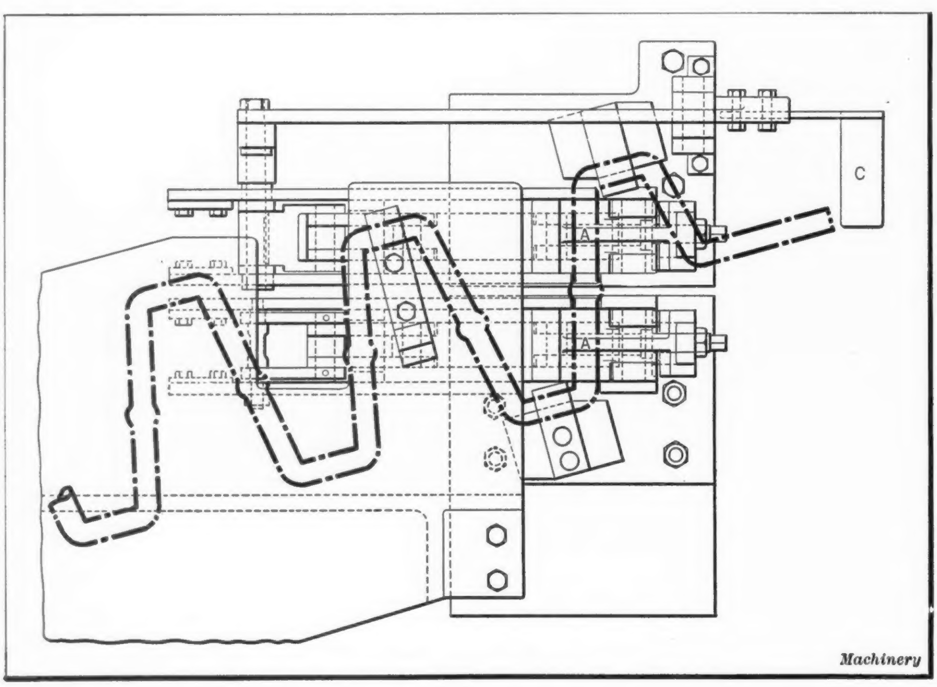


Fig. 1. Plan View of Special Arrangement provided for holding the Work while butt-welding

Welding the Sections Together

After producing the sections as described, they are welded together on a standard butt welder equipped with a special quick-acting clamping device for holding and gaging the

work. Fig. 1 shows a plan view of this fixture and Fig. 2 a sectional elevation. From Fig. 1 it will be seen that there is a right-hand and a left-hand clamping arrangement consisting of a gun-metal base and swinging jaws *A*, the latter having copper contact inserts. Each swinging jaw is opened and closed by means of a toggle mechanism operated by an air cylinder *B*, Fig. 2, which is suspended at the back of the machine. These cylinders are supplied with air at 75 pounds pressure and controlled by the operator or his helper. At the front and back of the machine are foot-control levers *C*, *D*, and *E* which permit the operation of the jaws independently of the air cylinders. The arrangement of the air valves and the foot-levers is such that the operator has control of the clamping device on the left-hand side of the machine, while the helper has control of the other clamp.

In operation, the helper places an end section in the part of the fixture under his control, while the operator places a center section from his side. These two parts are then welded together, and a word may be said about the operation. No sparks fly, there being a steady rising of heat with a continuous pressure, until the steel is reduced to a pasty mass, which runs together. This is the distinctive feature of the weld. There is no flash or burn. When the metal is hot enough, the current is cut off, the parts brought together to a gage point, the current thrown on for an instant only, and then shut off again.

Before releasing the clamps, the operator takes a pair of tongs which has rollers inset in the jaws, places them over the hot weld and rolls the metal into a neat rounded shape. The operator then throws open the air valve and picks up another center section ready to place it in position for the next weld. His helper, in the meantime, releases the finished work, turns it over, and reclamps it in position to receive the next section. The two men assemble an average of one hundred eight-throw cranks per eight-hour day.

Method of Inspection

After the welding operation, the cranks are inspected and tested on a large surface plate equipped with special clamps and gages. The cranks are tested for strength, straightness, and balance. This is the last operation in the forge department, from which the crank passes on to undergo simple machining operations and then to the assembling department. Cranks made by this process have been found to be truer, stronger, and more uniform than those made from single bars. They compare favorably from a production cost basis with single-bar cranks, and require only one-fifth the equipment necessary for single-bar cranks.

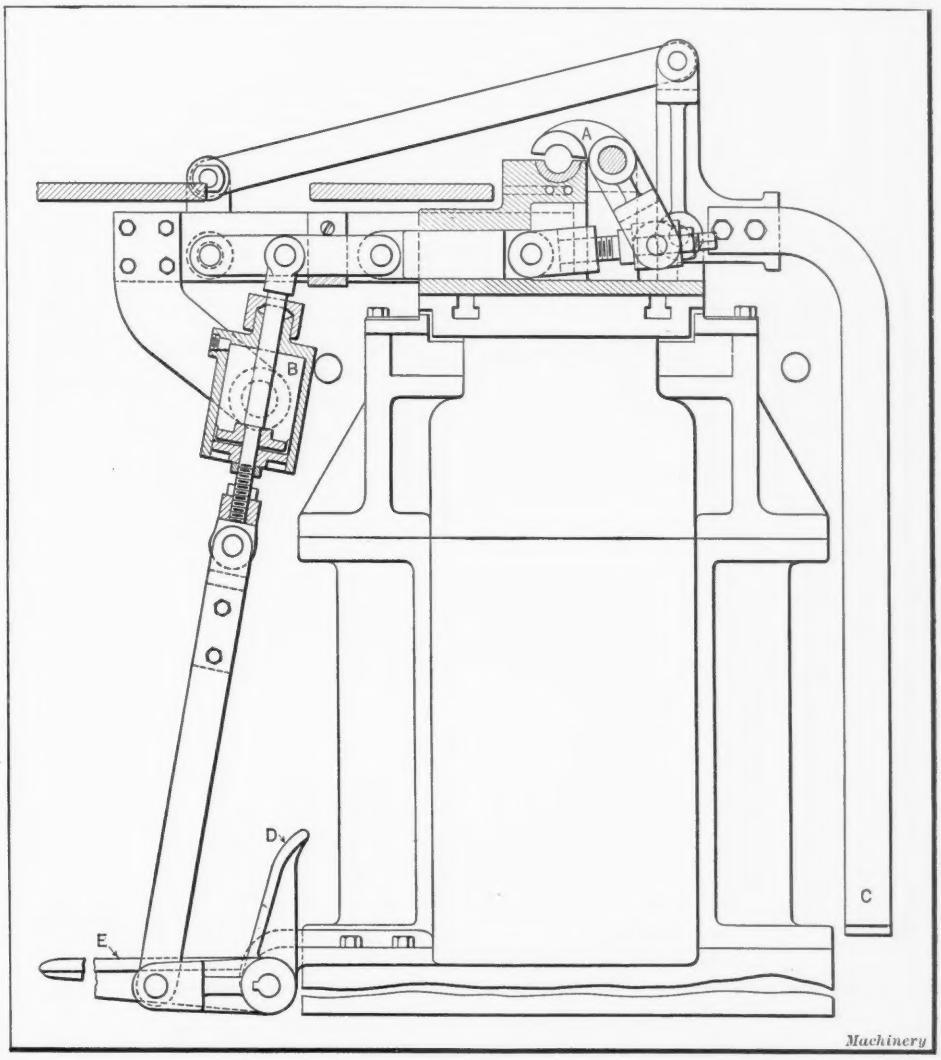


Fig. 2. Side Elevation of the Special Equipment shown in Fig. 1

* * *

The first meeting for the season of the Pittsburg chapter of the American Society for Steel Treating was held at the William Penn Hotel, September 2. Dr. N. B. Hoffman, metallurgist of the Colonial Steel Co., spoke on "Some Phases of the Metallurgy of Tool Steel."

THE TRACTOR INDUSTRY

In an address made by Dave E. Darrah, of the Hart-Parr Co., Charles City, Iowa, before the Minneapolis Section of the Society of Automotive Engineers, it was stated that in 1919, 500 companies were organized to build tractors. Of these, 300 actually marketed sufficient tractors to warrant their being listed as manufacturers. Today—five years later—only 20 of these firms remain in the business and only 10 of them are actually building new machines; the remaining 10 are simply disposing of accumulated stocks. As an indication of the present and future positions of the tractor with the farmers, Mr. Darrah cited the following significant result of a canvass of 20,000 tractor owners: 96 per cent stated that they had made definite savings of time and cost by the use of farm tractors; 90 per cent said that the tractor had enabled them to raise larger crops; 85 per cent said that the tractor had eliminated the hired-help problem; 90 per cent expressed the opinion that the tractor had done their plowing better than horses; 85 per cent used their tractors for jobbing work off the farm and made average earnings of $630 per year in this work; 96 per cent agreed that the modern farm tractor is successful in giving continuous service; 90 per cent stated that the tractor is a paying investment.

This investigation showed further that tractors are now being used 75 days per year on an average. Thirty-nine days of this time represents work in the field, such as plowing and harrowing; the tractors are used for belt-power work the remaining 36 days. Sixty per cent of the tractors now being manufactured are used to replace machines that have outworn their usefulness.

The Machine-building Industries

OWING to the political situation, business generally has assumed a waiting attitude. Nevertheless, accurate observations of business conditions, based upon specific data such as collected by the Federal Reserve Banks, indicate that during the last two months there has been a gradual improvement in the iron and steel industry, and a number of the other important industries have also shown increased activity. There is a spirit of greater confidence among the men controlling the larger business enterprises of the country. Credit remains cheap and abundant, and the progress made with regard to the Dawes plan gives promise of more stabilized conditions in Europe, which cannot help but ultimately aid in establishing improved conditions in this country. The general conditions underlying business are sound at the present time, but no great change in volume of production is expected until after the election.

The Machine Tool Industry

The increased activity in the iron and steel field has not yet reached the machine tool industry to any appreciable extent. Some manufacturers mention that they receive more inquiries, but the actual sales have not yet been appreciably greater than during the summer months. The railroads have ordered a considerable number of cars, and increased activity in the railroad field will have a favorable effect on machine tool demand. In the automotive industry the demand will be largely for replacement purposes. There is a great deal of equipment in many automobile plants that ought to be replaced by the better production tools of modern design now available. The reduction of manufacturing costs—not of labor costs alone—is the slogan that will appeal to the automobile industry.

In the small tool field, the demand is naturally better than in the machine tool field, because production in many of the machine-building industries is going on at a fair rate—nearly 270,000 automobiles were built in August—and hence, small tools are constantly being used; but orders are generally small, indicating an extreme tendency toward hand-to-mouth buying.

The Automobile Industry

The automobile industry appears to have regained its balance. The production in August was 2 per cent above that of July, the total number of cars and trucks manufactured being 268,480. The August pace in production has been maintained during September, and when the figures for September are available it is expected that they will be equal to those of the previous month. The general condition in the automotive trade is better than it was earlier in the year; dealers are not overstocked to the extent that they were then, and the market generally is in a healthier condition. Improved sales in rural districts are reported. The sentiment in the industry generally is optimistic, and the total production for the present year points toward an output of nearly 3,500,000 cars and trucks. With about 16,000,000 cars now in use in the United States, it is estimated that the annual replacement requirements are 2,000,000 cars. The export outlook is also better than it has been for many years. Over 200,000 cars were exported during the last fiscal year, and the exports are constantly increasing.

The Iron and Steel Industry

The operations in the iron and steel industry are now well above the 50 per cent capacity level, and are expected in a few weeks to be at about two-thirds capacity. Another encouraging sign is that for the first time in many months unfilled orders of the United States Steel Corporation are showing an increase. The recent activity in the buying of railroad equipment has had a stimulating effect upon the iron and steel industry, and in some districts the demands for structural steel are better. The steel ingot production in August was 25 per cent greater than in July. There have been some advances in pig iron prices, but there has been no appreciable change in steel quotations.

The Railroad Situation

The new orders placed for railroad equipment will exert a healthy influence on the machine-building and metal-working industries generally. On August 1, the last date for which complete statistics are available, 88,800 freight cars had been placed in service since the first of the year, and at that time there were over 52,000 additional cars on order. Since that time several railroads have placed substantial orders, including one by the Pennsylvania Railroad for 10,000 cars and one by the Illinois Central for 6200. During the first seven months of the year, 1268 locomotives were placed in service, and over 400 were on order for delivery at an early date. Large rail orders from some of the railroads either have been recently placed or are expected shortly. Freight traffic is increasing and during the week ending August 30 again exceeded the million-car mark, which was the first time this year that so high a figure for car loadings had been reached. The increased loadings were due to greater shipments of practically all commodities.

The farm machine and farm implement industry shows but little change, production remaining about the same as during the last few months. Some manufacturers, however, report an increase in orders for spring delivery. Many farmers are now using old and worn out machinery, which fact, coupled with the higher prices being received by farmers for their products, is expected to provide the impetus for increased buying of farm machinery early next year.

* * *

SIMPLIFICATION THROUGH STANDARDIZATION

The Division of Simplified Practice of the Department of Commerce, in its report to the Secretary of Commerce, Mr. Hoover, who established this division three years ago, states that most notable among those who have cooperated with the department in reducing grades and sizes, is the lumber industry, where 60 per cent of the items ordinarily carried in lumber yards have been eliminated. It is said that the reduction of waste through the elimination of unnecessary grades and sizes will amount to $250,000,000 a year in this industry alone.

Other interesting examples of simplification through standardizing on certain sizes are as follows: Metal lath has been reduced from 125 to 24 varieties; in forging tools, 46 per cent of the types, sizes, and weights have been eliminated; roofing slate has been reduced from 21 thicknesses to 10, from 60 sizes to 30, and from 17 types to 8; blackboard slate, from 90 sizes to 3 for fixed wall blackboards; from 141 sizes to 14 for portable boards; and from 20 sizes to 8 for school slates; woven wire fencing has been reduced from 552 styles and sizes to 69; milk bottles from 49 to 9, and milk bottle caps from 29 to 1; bolts and nuts for farm equipment from 1500 to 840; hot water storage tanks from 120 to 14, and so forth throughout a long list of manufactured goods where the manufacturers have cooperated with a view to reducing costs through simplification and standardization. There is no doubt that in every industry there are ample opportunities for standardization and the elimination of unnecessary sizes and types.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Besly Crankshaft Lapping Machines

IN automobile plants it has been customary to polish crankshaft bearings by placing the crankshaft in a speed lathe and applying strips of fine emery cloth by hand. To enable this operation to be performed in a quicker and more economical manner, Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill., have recently introduced on the market two machines which employ felt polishing wheels charged with ground glass or other fine abrasive. A mechanical means is used to feed the wheels to the work. One of these machines is equipped with three wheel-heads, as shown in Fig. 1, for lapping the line bearings, while the other is provided with two wheel-heads, as shown in Fig. 2, for lapping the throw bearings. It is stated that with a battery of three of these machines and four men, five crankshafts, or a total of thirty-five bearings, are averaged per minute.

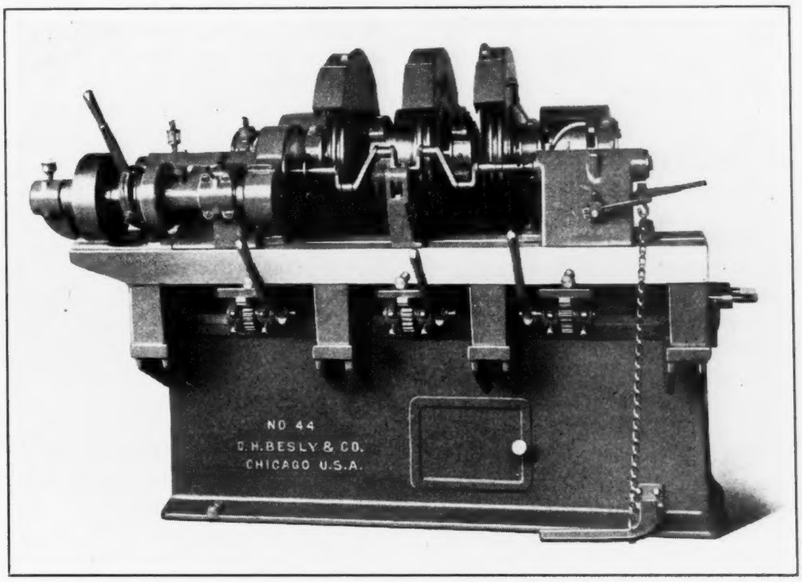


Fig. 1. Besly Three-head Machine for lapping the Line Bearings of Automobile Crankshafts

From the rear view of the two-head machine shown in Fig. 3, it will be seen that dovetail ways are machined on the bed to receive adjustable saddles which support the wheel-head slides. Supports are cast on the front of the bed to hold the work-table. On the three-head machine this table supports a crank-driving head, a tailstock, work-rests, and a driving mechanism. The crank-driving head is mounted on the left-hand end of the table. It is equipped with a driving pulley which is mounted on a friction clutch sleeve. The shipper sleeve has a tapered nose which, when thrown to the right, disengages the clutch and engages a stationary friction cup which instantly stops the work spindle.

The work-spindle is driven through a spiral gear mounted on one end of the clutch driving shaft, which engages a spiral gear on the spindle. The driving shaft is equipped with eccentric bushings to take up backlash in the gearing. The work-spindle is furnished with a faceplate for attaching various kinds of work-drivers and with a center for carrying the work. The tailstock is of a quick-acting type actuated by hand or foot through a compression spring and cam-lever movement. The spindle can be set for a sliding movement or clamped rigidly. Two hardwood blocks on the work-rest are adjustable to suit any size of crank, and the rest may be clamped at any point on the table between the centers.

Movement of the wheel-head saddles along the bed is controlled from each end of the bed by means of screws. The wheel-head slides are mounted on long dovetail guides on top of the saddles, and taper gibs provide for their adjustment. The front end of the slides is equipped with a rack and pinion movement controlled by an operating lever, this mechanism being used for moving the wheels to and from the work. Stop-screws in the table casting are employed to regulate the pressure of the wheels against the work.

The wheel-head spindles are equipped with ball bearings enclosed in dust-proof housings, and the driving pulleys are shrunk on the spindles. The spiders that carry the hard felt wheels are so designed that the flanges fit into a recess cut into the sides of the wheel, and do not project and interfere with the crankshaft cheeks. On the central head-spindle the wheel spider is attached directly to a flange on the driving pulley, as this head is limited for space. The lapping wheels are made of

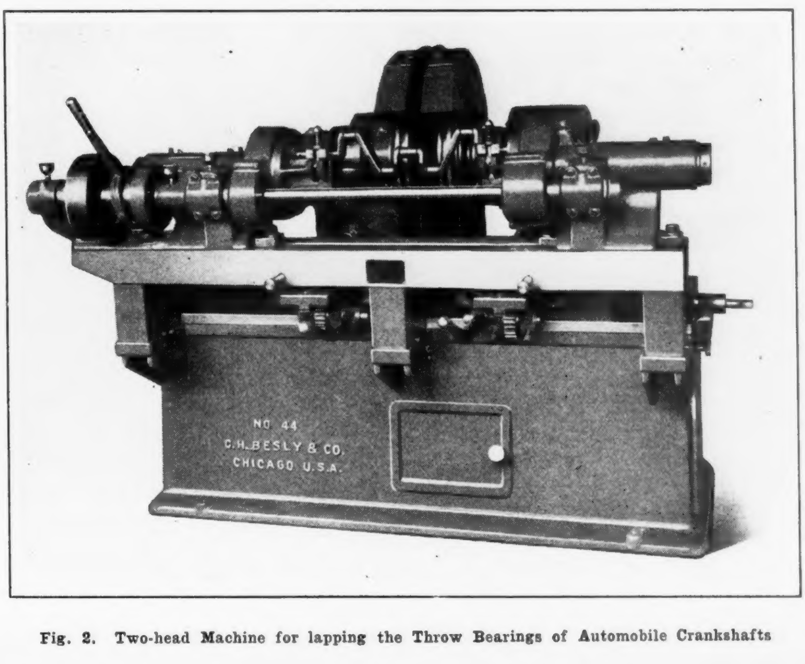


Fig. 2. Two-head Machine for lapping the Throw Bearings of Automobile Crankshafts

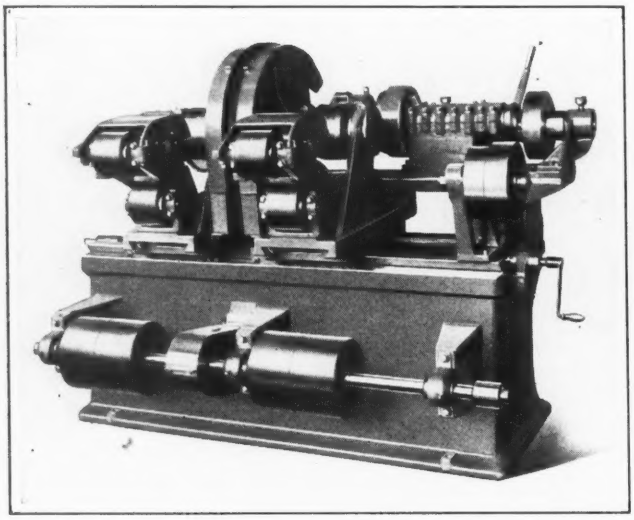


Fig. 3. Rear View of the Two-head Machine, showing the Driving Arrangement

hard white felt and of a width to suit the bearings being lapped, no endwise movement being required except in special cases. All wheels are guarded by hoods which have an adjustable front lip. The wheel-spindle speed is 1500 revolutions per minute, and the crank-spindle speed, 320 revolutions per minute.

The two-head machine is provided with two crank-carrying heads and suitable driving mechanism, as shown in Fig. 2, the crank-carrying heads being composed of two separate units attached to each end of the table. The clutch driving shaft of this machine has two spiral gears which mesh with larger gears on the crank-carrying spindles. In other details of construction this machine is similar to the three-head machine. With this machine, however, the crank-spindle speed is 150 revolutions per minute, while the wheel-spindle speed is 1500 revolutions per minute.

The motor used on the two-head machine is of 7½ horsepower capacity, and on the three-head machine, 10 horsepower capacity. The motor is mounted in one end of the base and transmits power to the jack-shaft through a silent chain drive which is fully enclosed. Openings at one end of the base and at the front provide access to the motor. The jack-shaft is mounted in three ball-bearing pillow blocks attached to supports cast on the base, as shown in Fig. 3. Two and three sets of drum pulleys are mounted on this shaft to allow the wheel-heads to be moved back for changing the wheels.

Power is transmitted to the wheel-spindles by belts which pass over two ball-bearing idler pulleys and a third idler pulley mounted on a swinging bracket. The bracket takes up all slack in the belts as the wheel-slides are moved to and from the work. Power is delivered to the work-shaft from a driving pulley attached to one end of the jack-shaft, two belts being used. One of these connects the jack-shaft pulley to a cone pulley, and the other connects the cone pulley to the work-shaft pulley. The cone pulley is also provided with means for taking up slack in the belts. Belt-driven machines make use of a countershaft which must be mounted directly over the center of the wheel-spindles. The three-head machine may also be used for lapping the main bearings of camshafts.

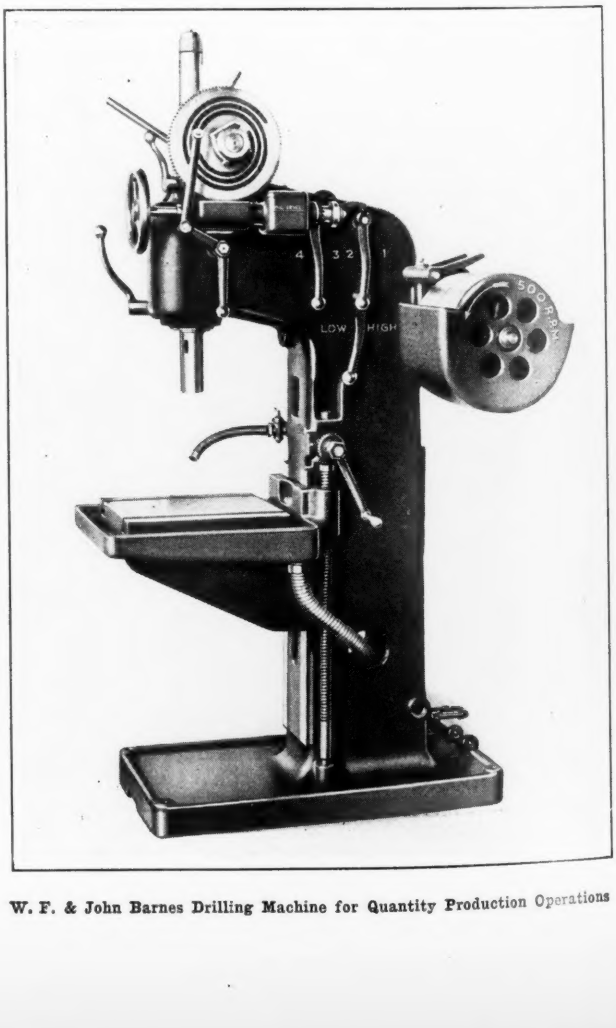
W. F. & JOHN BARNES DRILLING MACHINE

To meet the requirements of drilling, reaming, tapping, boring, counterboring, spot facing, etc., in quantity production work, the W. F. & John Barnes Co., Rockford, Ill., has recently developed the 20-inch drilling machine illustrated. The basic machine is equipped with a belt drive, but there is provision for using a direct-connected motor drive. Eight mechanical speed changes are obtainable, ranging from 72 to 500 revolutions per minute, and twenty-four feed changes ranging from 0.010 to 0.231 inch per spindle revolution. Of the feed changes, eight are regularly supplied with the machine, and pick-off change-gears are furnished for the remainder.

The main drive is contained in the column, which forms an oil-tight compartment, insuring constant lubrication of the different parts. All gears are made of alloy steel and heat-treated, and the shafts have multiple splines. From the main gear train the drive is carried through a pair of bevel gears to the spindle, the spindle driving gear being located immediately above the main bearing, so that torque in the spindle is reduced to a minimum. An important feature of the spindle driving gears is that they can be adjusted at any time.

From the top shaft in the speed transmission, power is delivered to the feed mechanism by means of spiral gears. Sliding gears are shifted by a lever at the front of the machine to obtain the feed changes. From these gears a shaft connects with the pick-off change-gears which are located at the left-hand side. A second shaft carries power from the pick-off gears to the feed worm and worm-wheel at the right-hand side of the column. There is a special spiral-grooved disk attached to the cross-shaft carrying a stop which may be set to automatically trip the feed at any desired position. Patents are pending for this device. A heavy spiral spring is employed to counterbalance the spindle and to automatically return the spindle to the starting point after the feed mechanism has been disengaged.

Attention is called to the fact that the table elevating screw is placed close to the column of the machine. The claim is made that as this location of the screw reduces the distance from the screw to the bearing of the table on the column, the tendency of the table to spring the base of the machine is reduced in direct proportion to the amount that the length of the lever arm has been reduced. There is the usual arrangement of pump and piping for circulating coolant to the drill and work from a reservoir in the base of the column. The machine is rated as having capacity for driving a 1½-inch high-speed drill through steel. The design is such that the machine may be used as a gang drill, with any number of spindles up to six.



W. F. & John Barnes Drilling Machine for Quantity Production Operations

WARNER & SWASEY UNIVERSAL TURRET LATHE

The aim in view in designing the No. 1-A universal hollow hexagon turret lathe, now being introduced on the market by the Warner & Swasey Co., Cleveland, Ohio, was to produce a machine having a high productivity over a wide range of work. For this reason, special attention was paid to obtaining power and rigidity in combination with light weight. The exertion required by the operator in handling the machine and changing the speeds and feeds, in order to take full advantage of present-day tool steels, is recognized as an important factor in the output of a machine, and so attention was also directed toward obtaining a machine that could be operated with ease. The power provided is sufficient to take full advantage of the double-carriage principle, in which the simultaneous use of the tools in both the hollow hexagon turret and the square turret materially reduces the total time of the operation.

While the new machine is similar in design to the Nos. 2-A and 3-A universal hollow hexagon turret lathes built by this company, it incorporates many new and important features. Among these features are included an all-steel geared head, an increased number and range of feeds, a quick method of changing feeds from the apron of the carriages, a new patented turret binding mechanism, and new methods of tooling.

Fig. 1 shows the machine equipped for chucking work, being provided with a 12-inch three-jaw scroll chuck. The jaws of this chuck are reversible for inside and outside gripping, and can be easily replaced with soft or special jaws, when these are more suitable for holding irregular-shaped work. There is a maximum swing of 13¾ inches over the carriage and 16¾ inches over the ways. For handling bar work, the machine is equipped with an automatic chuck collet that will accommodate round bars up to 2½ inches, square bars up to 1¾ inches, and hexagonal bars up to 2 inches, the maximum turning length being 26 inches. The collet may be adjusted a total of 1/16 inch to compensate for slight variations in the size of the bar being handled. The bar chuck is easily operated by a lever, and the entire attachment can be quickly removed when the machine is to be set up for chucking work.

The head is cast integral with the bed, as in all other machines built by this company, and the gears are made of heat-treated steel and operate in an oil bath. The design of the gearing is compact, as may be seen from Fig. 2, which shows the head uncovered. This system of gearing provides twelve spindle speeds, both forward and reverse, ranging from 20 to 477 revolutions per minute. The wide selection has been chosen to adapt the machine to turning, boring, or threading large and small diameter surfaces on the same piece. Speed changes are quickly made by operating levers on the head. Starting, stopping, and reversing of the machine is accomplished through a double friction clutch on the back-shaft of the machine by means of the handle that projects to the front of the head on the right-hand end.

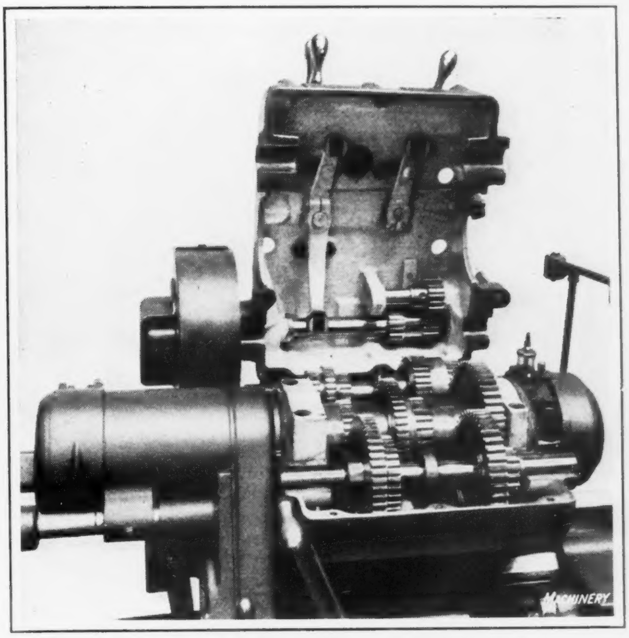


Fig. 2. Design of the Geared Head

Power may be supplied to the single-pulley drive by belt direct from a countershaft or lineshaft, but one of two motor drives can also be furnished. In one style the motor is mounted on the head-end leg and connected by belt to the single-pulley drive, this arrangement being standard when the countershaft is omitted. However, where it is required to keep the entire motor drive within the floor space occupied by the machine itself, an overhead drive is recommended, with the motor mounted on the plate on the head and driving the main pulley through a chain.

The familiar hollow hexagon turret of Warner & Swasey machines is used, the turret being provided with broad faces to which the tools and holders are bolted from the inside. These faces are bored and faced by tools held in the spindle of the machine itself after the final installation of the turret, so as to insure accuracy of alignment. One of the especially interesting features of the machine is a patented binding mechanism for clamping the turret rigidly in position. As shown in Fig. 3, the mechanism consists of a two-part collar *C*, which has a groove that embraces the tapered flange *A* on the bottom of the turret and the tapered flange *B* on the turret seat. By means of right- and left-hand screws, which are manipulated through lever *D*, the two halves of this collar are bolted together to bind the turret tightly to its seat. The same lever operates the turret lock bolt *E*, so that this bolt is raised when the turret is clamped, and lowered when the turret is unclamped. This binder is said to hold the turret as though it were cast in one piece with the saddle.

Sixteen feeds are furnished for the hollow hexagon turret, eight of these being readily obtained by operating two levers located on the saddle apron. The other eight feeds are obtained by operating an additional lever at the head end of the machine to shift a change-gear located in the gear-box at this end. The feeds range from 0.0045 to 0.120 inch per spindle revolution. An improved rapid power traverse has been provided for moving the turret to and from the working position with little effort on the part of the operator. This traverse can-

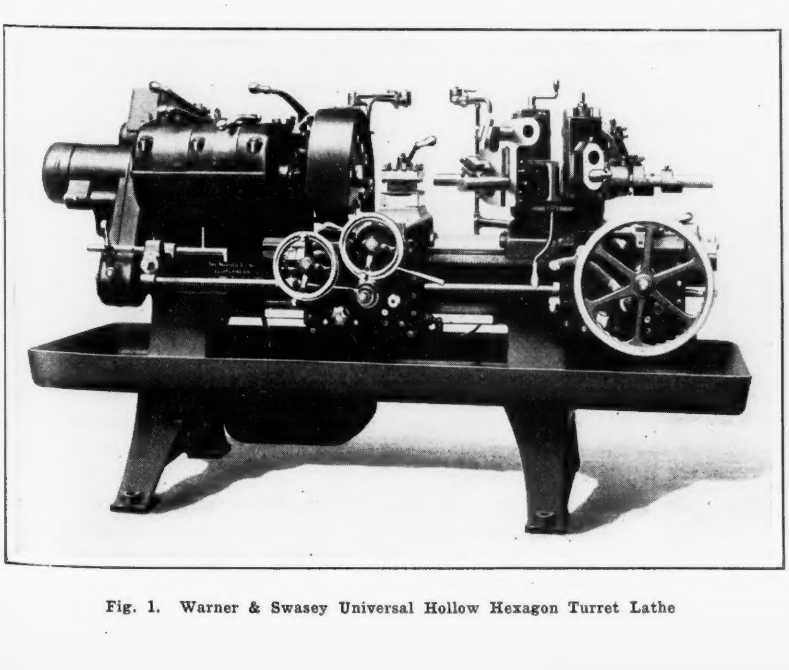


Fig. 1. Warner & Swasey Universal Hollow Hexagon Turret Lathe

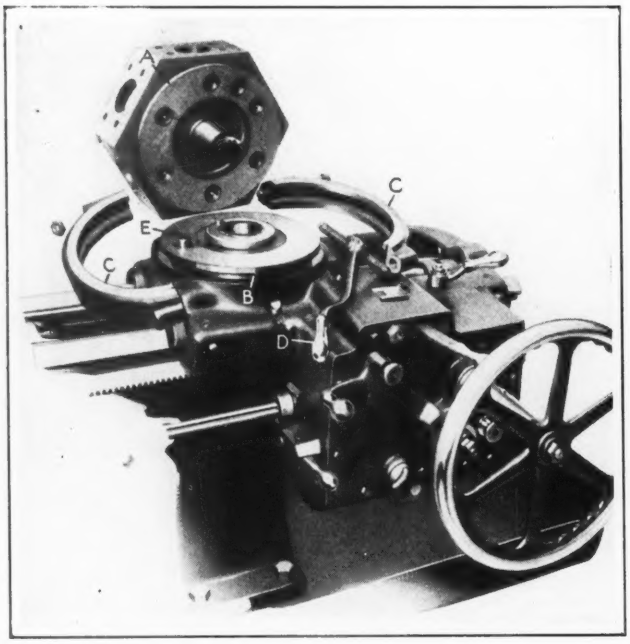


Fig. 3. Construction of the Turret Clamping Mechanism

not be engaged while the turret is under a feed. It can be arrested at any point and automatically disengages as the turret reaches the end of the bed.

The side carriage is of the regular Warner & Swasey design which does not extend across the ways of the machine. It is mounted on a front vee and gibbed to a lower dovetailed bearing on the front of the bed. The entire side carriage may be moved to the left, past the chuck and out of the way of the turret saddle when not in use, so as to increase the possible swing. The square turret on the side carriage may be clamped in any position by a quarter turn of the binder handle. Sixteen longitudinal and sixteen cross feeds are provided for the side carriage, and these may be obtained independently of the hexagon turret carriage. With this wide range of feeds, turning, facing or recessing operations may be performed at the proper feed by tools on the square turret, while tools on the hexagon turret are engaged in drilling, boring, or turning at the desired feeds. The cross travel of the square turret is 8 1/4 inches, and the longitudinal travel of the side carriage, 22 3/4 inches, but the latter dimension may be extended to a maximum of 30 1/2 inches by removing two dogs on the stop-roll.

Recent experience, particularly in the automobile industry, has shown the desirability of using standard units of equipment, because of the high cost of special machines and tools. For this reason, standard tool equipment for bar and chucking work on this machine has been made complete, so the machine may be adapted to a wide range of production requirements without the use of special tools.

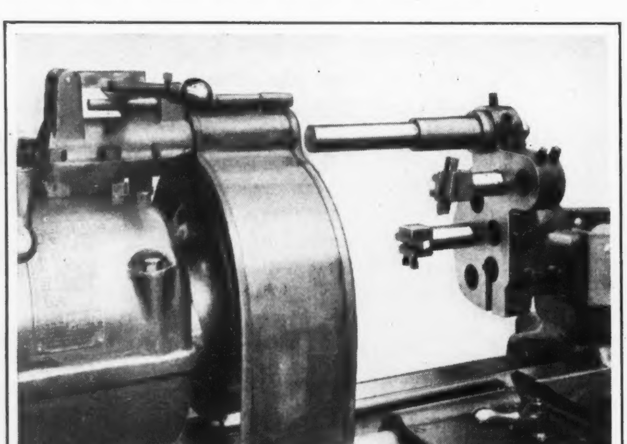


Fig. 4. Turning Head with Overhead Pilot-bar

An entirely new accessory, which is standard for this machine, is the overhead piloted turning tool shown in Fig. 4. On this turning head the pilot-bar, which is adjustable in the body of the turning head, enters a corresponding bushing adjustably mounted in the head of the machine. The adjustments provide for taking up any loss in alignment that may arise. This design compensates entirely for the loss of a center pilot-bar in operations where the latter type cannot be used, and increases the rigidity of the machine and tools in heavy work, where both center and overhead pilots may be employed. A geared oil-pump is coupled direct to the power traverse drive shaft to deliver cutting lubricant at the rate of three gallons per minute while the machine is in operation. The weight of the machine with bar equipment is about 4950 pounds.

V & O AUTOMATIC BAR-FEED PRESS

An automatic bar-feed press in which a number of operations, such as forming, swaging, drawing, redrawing, and piercing, may follow the blanking operation has recently been brought out by the V & O Press Co., Hudson, N. Y. This machine is a development of an old form of automatic press known as the "Cut and Carry" type, which was designed to perform only two operations—blanking and forming. A feature of this bar-feed machine is its ability to handle and accurately gage pieces that are changed in shape

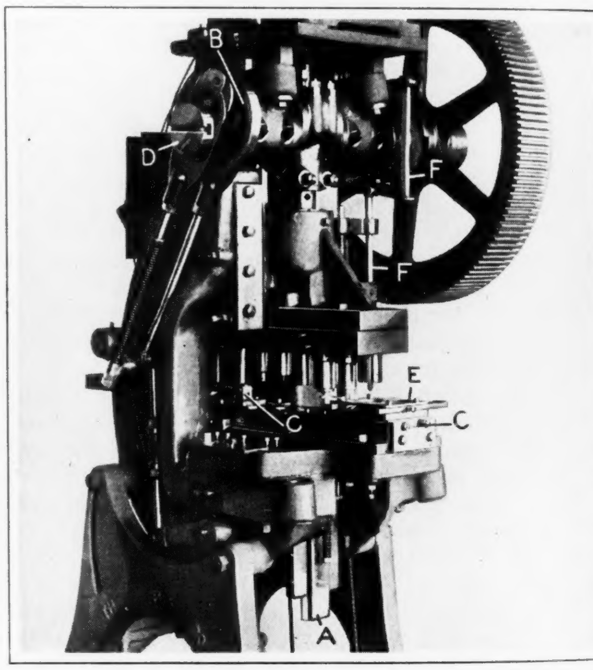


Fig. 1. V & O Automatic Bar-feed Press in which Various Operations may be performed simultaneously

and size by the successive operations. This is possible because the feed-bar is made with a series of openings that correspond in size and shape to the piece in its various stages of formation, the blank fitting the first opening.

The machine is equipped with a slide which is of double length to insure a steady support, and which extends a considerable distance forward so as to accommodate all the punches required for the different operations. Other features of interest include an under-motion mechanism and slide *A*, Fig. 1, which are actuated by cam *B*. The reciprocating feed-bar *C* is interposed between the punches and dies and is operated from cam *D*. Only the blanking die *E* at the front of the press is located above the feed-bar, all other dies being beneath the bar.

As the strip of metal is passed through the blanking die, either by hand or a roll feed, the blank is cut and dropped through the die upon a plunger connected to the under-motion. During the up stroke of the press slide, the feed-bar moves forward and dwells, with its various openings

directly over the different dies, a sufficient period to permit the under-motion to push the parts out of the dies into the feed-bar. The bar then carries them back to the next-operation die, where the bar dwells until after the next down stroke. Thus the new blank is pushed by the under-motion into the first opening of the bar and carried by the bar into line with the second-operation punch and die. At the next downward stroke of the press, the second-operation punch forces the blank out of the bar and into the forming die. Then, when the press makes the succeeding up stroke, the bar again comes forward, bringing the second opening over the piece formed in the second die, and the under-motion pushes the piece up into the bar as before. When the bar travels back before the next down stroke, the piece, as formed in the second die, is brought into line with the third punch and die. This procedure is continued through the entire series of operations. All operations are performed simultaneously, a piece being completed at each stroke of the press.

There is a safety stop mechanism *F* connected to the bar feed and the press clutch, so that, if for any reason the bar does not register the pieces of work in proper alignment with the different punches and dies, the clutch is automatically disengaged and the press stopped without damage to any part. Also, the bar is actuated through springs which compress if the bar accidentally becomes jammed and thus bring the safety device into action to stop the press. By equipping the machine with a magazine *G* and a roll feed *H*,

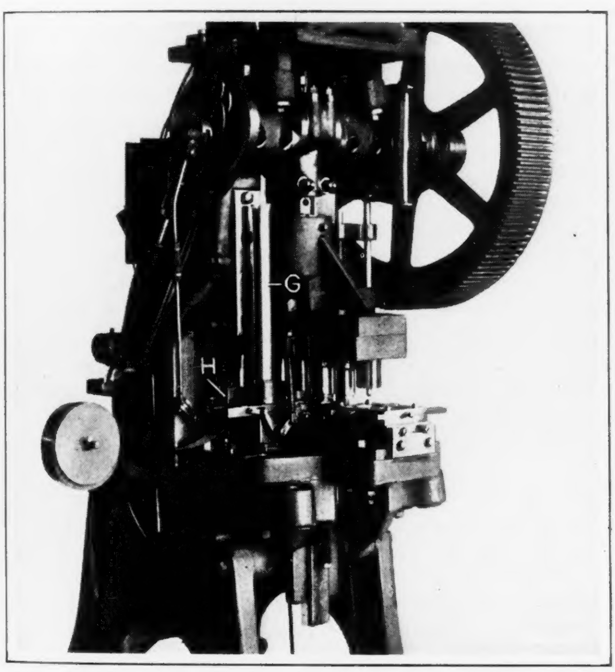


Fig. 2. Press equipped with Auxiliary Magazine and Roll Feeds for assembling Separate Pieces to the Main One

as illustrated in Fig. 2, separate parts to be assembled with the main piece being made on the machine, may be introduced midway in the series of operations.

Credit for the successful operation of this feed is given in large measure to the double-length slide. It will be seen that the series of operations necessitates a large spread of the dies with the blanking die farthest from the center of pressure. In the set-up illustrated the blanking die is located 8 inches off center. However, the double-length bearing obtained by extending the slide above the top of the press frame is said to hold the punches and dies in alignment. It is stated that 20,000 gross of blanks such as shown at *D*, Fig. 3, were produced without regrinding the tools.

Fig. 3 also shows several other types of work made on this machine. The operations performed on the sheet-metal chain link *A* consists of blanking, edge forming, edge coining, perforating, and sizing. Two links are made at each stroke of the press. The tin clip *B* is produced with a wire

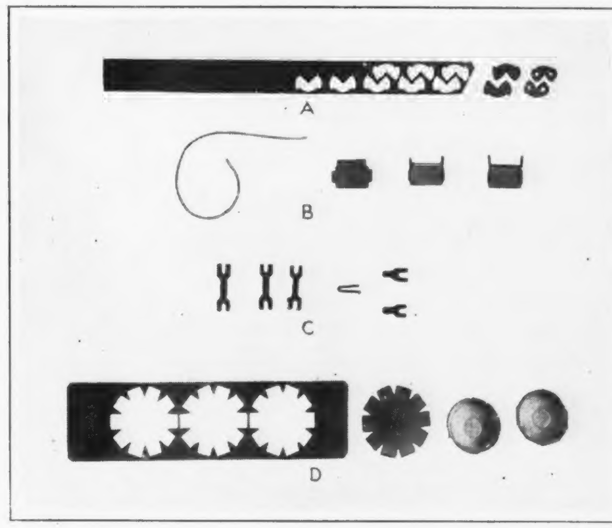


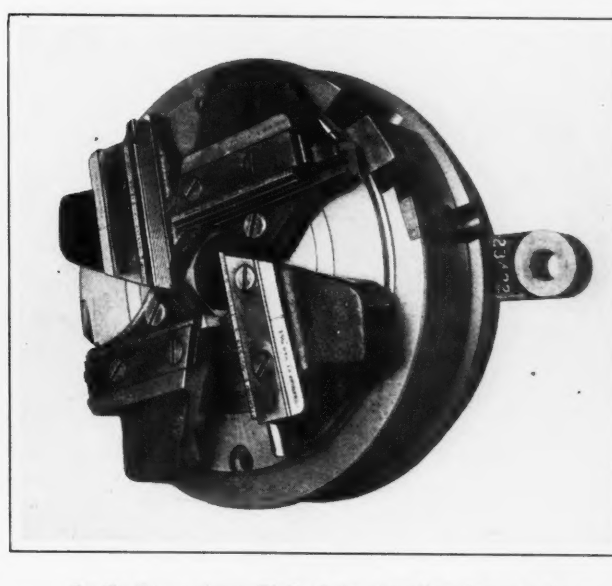
Fig. 3. Examples of Parts that may be handled readily in the Press

hinge, the clip being blanked and formed, the wire inserted and formed, and the hinge closed. Part *C* is blanked and formed in three successive operations, including one in which an automatically operated mandrel is employed. The tin bottle cap *D* requires a blanking die and three successive forming dies. In addition to these steps a wax-paper liner and a cork disk are cut and inserted in the cap.

LANDIS REVERSE-TAPER DIE-HEAD

In cutting tapered threads on crown bolts, the usual practice is to thread from the small to the large end. This is said frequently to cause nicking of the bolt body, which creates a tendency for the bolt to break in use at the point where it is nicked. With a view to overcoming this condition, the Landis Machine Co., Inc., Waynesboro, Pa., has placed on the market a "reverse taper" die-head which cuts the tapered thread from the large to the small end. Another feature of the die-head is that the square on the end of the crown bolt need not be true with the body, as the bolt is gripped on the body for the threading operation instead of on the square.

This die-head is made in a 1½-inch size only, for threading bolts up to 1⅞ inches in diameter with a maximum thread taper of 2 inches per foot. It is operated by two trip-rods attached to the front of the machine carriage. These trip-rods are fitted with adjustable nuts that engage lugs on the yoke ring which are diametrically opposite each other. The nuts are brought in contact with the lugs when



Landis Reverse-taper Die-head for threading Crown Bolts

the work is about to enter the die-head. Then, as the work advances, the yoke ring is pushed back, taking with it the operating ring to which the cam-shoes are attached. The cams are so designed that as the cam-shoes slide over them, the die-head is closed gradually to correspond with the thread taper. A different set of cams is required for each thread taper.

The travel of the cam-shoes must equal the length of the thread, as the die-head opens when the crest of the shoe passes the crest of the cam. Stop-screws provide for limiting the opening of the head. As the carriage is withdrawn, the head is automatically brought to the threading position. This head can be applied to any Landis threading machine having a capacity for 1½-inch bolts or more, but the machine must be equipped with a lead-screw attachment to insure a thread of correct form and lead. A special carriage front or trip-rod brackets are also required to accommodate the two trip-rods. The head is 11 7/8 inches in diameter and 7 5/16 inches long.

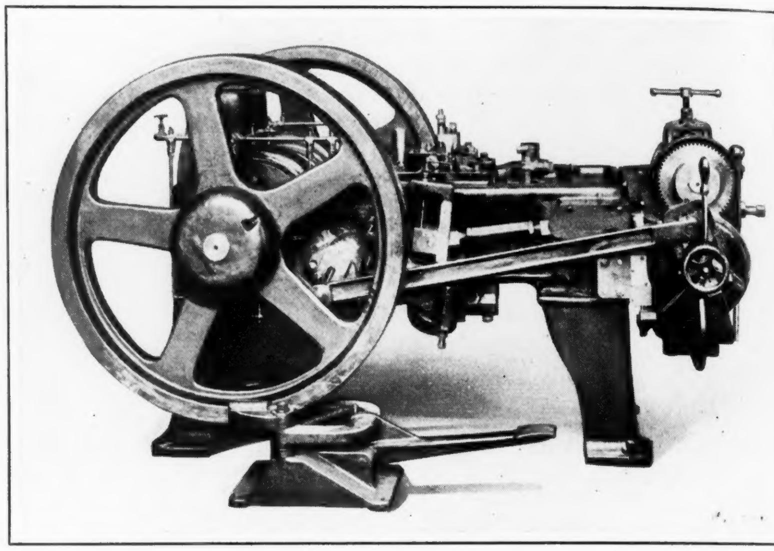


Fig. 2. Solid-die Double-stroke Crank Heading Machine

WATERBURY FARREL DOUBLE-STROKE CRANK HEADERS

A new line of double-stroke crank headers that includes both solid- and open-die machines has recently been developed by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., in a range of sizes for handling wire from 3/16 to 5/8 inch in diameter, inclusive. The open-die header is illustrated in Fig. 1, and the solid-die machine in Fig. 2. Both machines incorporate a number of interesting features. Safety devices which guard against the breakage of parts and the resultant slowing up of production, are provided for all mechanisms that require them, such as the feed control, the cut-off mechanism, the punch-shifter, the heading unit, and the drive. The roll feed mechanism is equipped with a safety device which prevents a short feed and provides an immediate and firm grip on the wire, regardless of the variation in its diameter. The feed movement is adjustable to a fine degree, and the exact amount of feed is automatically retained after having once been set.

There is a special connection between the crankshaft and the heading gate which furnishes a means for self-alignment. In combination with this connection, there is an adjustable wedge incorporated in the gate whereby the gate is automatically aligned in its ways. The adjustable wedge serves two other purposes; it provides for adjusting the distance between the punches and the dies, and it furnishes a means of freeing the header should it become stalled on centers.

Another feature is a spring compensator which enables all vertical adjustments of the punch slide to be made by means of two stop-screws located on top of the heading gate. The use of two flywheels is said to insure dynamic balance and a free-running shaft, thus doing away with springing and torsional strains. The flywheels are held on the crankshaft between friction disks which allow the wheels to slip in case the machine suddenly becomes stalled. A gravity feed lubricating system is incorporated to oil such surfaces as are not readily accessible when the machines are in motion.

In the open-die machine a cam-actuated cut-off and toggle gripping mechanism is employed to close the dies and advance them to shear the wire. The toggle mechanism is entirely enclosed in the frame and lubricated by a constant flood of oil. The toggles are independently adjustable to produce the desired holding pressure. A safety breaker is incorporated in the cut-off connection which functions in case any obstruction to the movement of the dies should occur.

An adjustable hinged steel cap encloses the dies of the open-die header within a pocket in the frame. The cap embodies a simple device for spreading the dies at the wire line, making it possible to design the cap so that it also serves as a safety device. The cap slopes toward the punches and allows clearance for the coning punch when it is forward on the heading stroke. If a blank is withdrawn from the dies by the coning punch and is carried up by it, the end will not come against the cap on the second stroke, but will enter the clearance space provided by the slope of the cap. When the coning punch again advances, the end of the shank will come up against the face of the dies and stall the machine. The feed stroke is regulated by means of a graduated adjustment, and the timing of the wire-stop, cut-off mechanism, punch-shifter, etc., can be accurately set. The open-die headers range in weight from 4450 to 32,800 pounds.

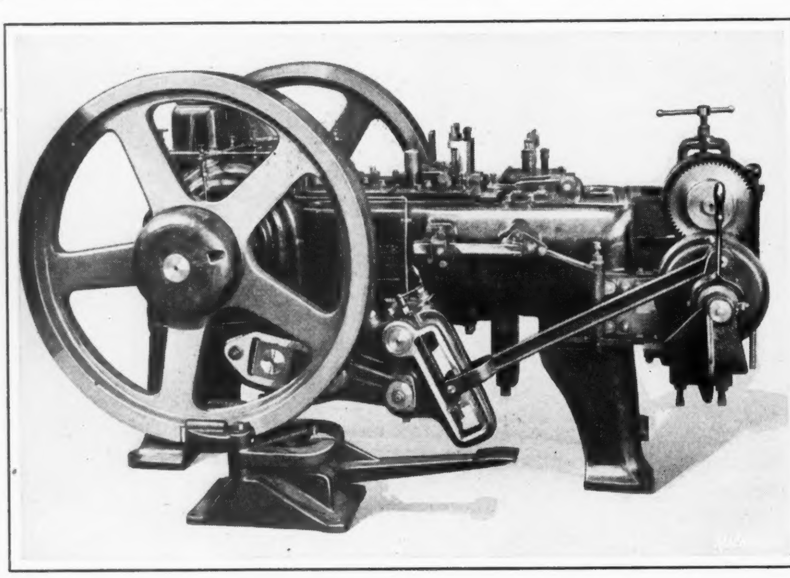


Fig. 1. Waterbury-Farrel Open-die Double-stroke Crank Header

An important feature of the solid-die machines is the cut-off carrier which is called the "fiddle bow." This device supports the blank in the cut-off knife until it is engaged by the coning punch. It is positive in action, and is lifted over the wire blank on its return movement to clear the advancing

coning punch. The construction enables the device to operate at high speeds. There are graduated adjustments for setting the feed, knock-out, and cut-off movements. A relief mechanism, sometimes required for heading blanks that have shoulders, squares, or other projections underneath the head, is readily applied to the end of the feed frame. Thus the change from a plain heading job to a special one is easily made. These machines range in weight from 3600 to 27,100 pounds.

BRIDGEPORT HEAVY-DUTY FACE GRINDER

Many improvements over earlier designs are embodied in a new heavy-duty face grinder which has recently been developed by the Bridgeport Safety Emery Wheel Co., Inc., 83 Knowlton St., Bridgeport, Conn. This Type 84 TS machine is provided with two speeds of work travel that are directly at hand from either the front or back operating positions. Two additional speeds are quickly obtained by reversing two gears at the rear. The four speeds are 8.2, 11.6, 16.2, and 23.1 feet per minute. By means of extra gears of varying ratios, many other speeds may be obtained. Another feature of the machine is that the grinding head may be set to grind flat surfaces or be swiveled around to produce any concave surface which it is desirable to grind on this class of machine. This adjustment for the head is quickly made by turning the handwheel at the rear. Levers are provided at both the front and rear for reversing the direction of carriage travel at any point in the stroke.

The main drive from the motor to the grinding wheel spindle is through a silent chain which is thoroughly enclosed to protect it from grit and dirt. An oil bath is maintained at a certain level to insure lubrication of this drive. The automatic cross-feed of the grinding wheel has been so constructed that a wide range of feed is obtainable at either or both ends of the carriage stroke. The feeds range from 0.0005 to 0.030 inch, and are adjustable to half-thousandths of an inch, the total movement of the wheel being 4 inches.

The water compartment has been divided into three individual stages of sedimentation, so as to require only a minimum amount of labor in insuring comparatively clean water at the grinding wheel. The water pump is direct-coupled to an individual motor which makes it a complete unit in itself. This is particularly advantageous in cleaning the pump and in using the water supply for flushing off the machine. Attention has been given to guarding the machine against flying spray.

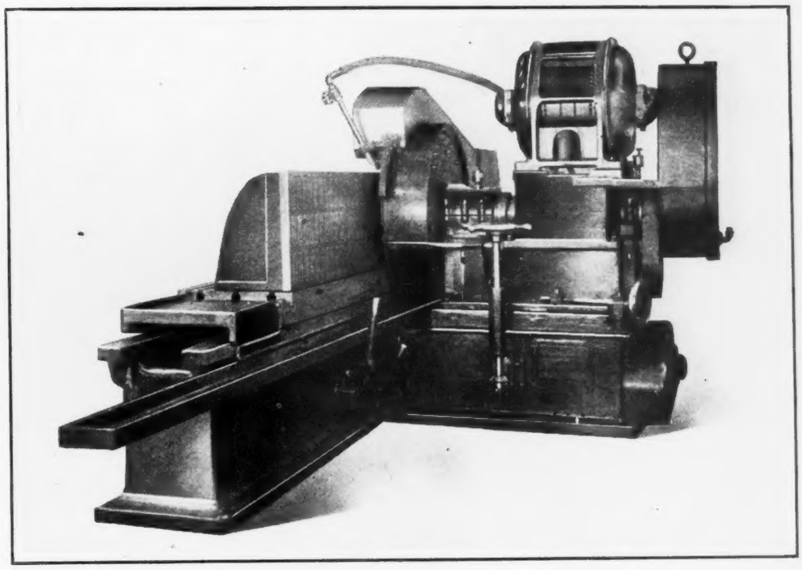


Fig. 2. Face Grinder equipped with Vertical-face Magnetic Chuck

The grinding wheel is of an improved 32-inch sectional type, consisting of fourteen sections carried in a steel-casting chuck. There is a provision for moving the sections forward quickly as they wear away, and the method of holding and locking them is such that practically the entire wheel may be used up. The spindle is equipped with two radial ball bearings and two thrust ball bearings. As illustrated in Fig. 2, the work-table may be provided with a vertical-face magnetic chuck for handling certain kinds of work. The table is built in lengths of 66, 86, 110, and 140 inches or more, and is 20 inches wide. The maximum height of work which can be handled is 22 inches.

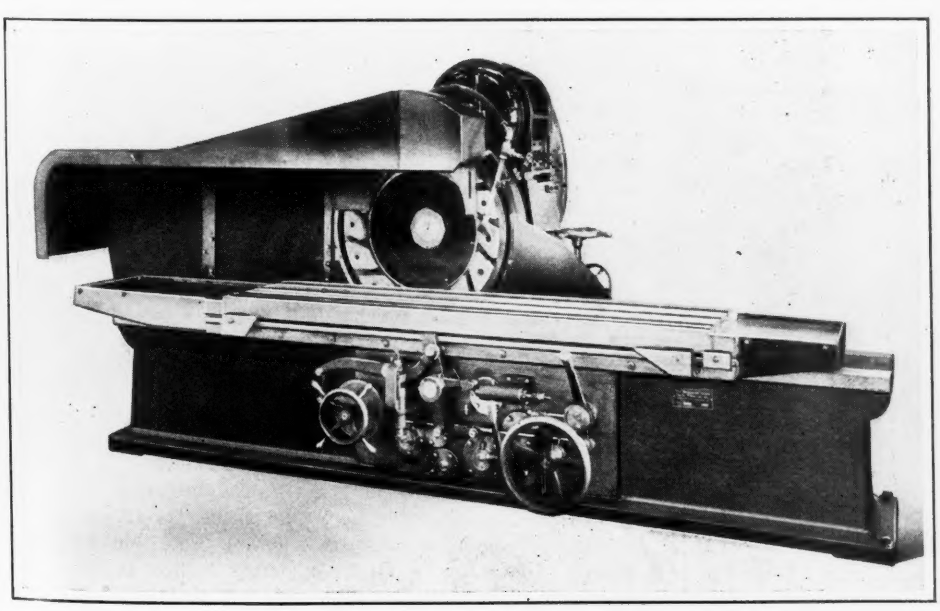
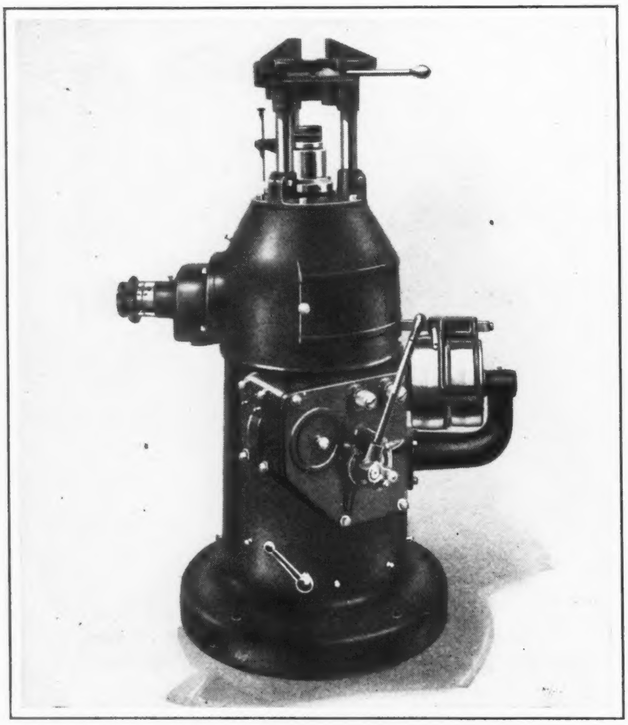


Fig. 1. Bridgeport Heavy-duty Face Grinding Machino

WICACO OIL-GROOVER

A number of improvements have been incorporated in the design of the oil-groover made by the Wicaco Screw & Machine Works, Inc., Stenton Ave. and Louden St., Philadelphia, Pa., which was described in the January and July, 1921, numbers of MACHINERY. For instance, rigidity has been assured by the use of a three-post chuck instead of the two-post chuck formerly supplied. The chuck is of the three-jaw scroll type, self-centering, and is quickly opened and closed by means of the handle, which operates through a pinion and gear. Also, a spiral-grooved sleeve has been substituted in the feeding mechanism for the former spiral gears, so as to make the feed more positive and uniform and provide longer life. While the machine is intended for cutting continuous grooves of a variety of designs, there is a new ratchet stop that permits intermittent grooving. The mechanism also includes simple disk cams which may be quickly changed. The spindle is now provided with six splines for driving.

A new flat rotary table top may also be supplied to adapt the machine to slotting dies or other work. In such an operation, the return stroke relief is



Wicaco Improved Oil-groover

always opposite the cutting point of the tool. Keyways may also be cut rapidly with the machine equipped with either the chuck or table top. In slotting dies or cutting keyways, the cutting is done on the down or draw stroke, eliminating any chatter or digging into the work.

The construction of this machine permits the handling of a large variety of sizes and shapes of work, as special fixtures can be used to meet requirements. In grooving operations, the work does not revolve, and can be inserted and removed while the machine is in operation. The stroke may be adjusted in increments of 1/16 or 1/8 inch from 0 to 7 inches, by simply turning two knobs on the outside of the machine. Graduations facilitate the obtaining of any desired length of stroke. There are independent clutches for both the rotary and reciprocating movements of the groover. The weight of this machine is approximately 700 pounds.

HERBERT HARDNESS TESTER AND STAND

A 24-kilogram pendulum hardness tester that is identical in principle with the 4-kilogram tester manufactured by Edward G. Herbert, Ltd., Chapel St., Levenshulme, Manchester, England, and described in June, 1923, MACHINERY,

Fig. 1. Herbert Pendulum Hardness Tester for Large Work

is now being introduced to the trade by the same concern. The new tester is illustrated in Fig. 1. It is intended for testing the hardness of rolls or shafts up to 30 inches in diameter or at any point on plates or other flat surfaces up to 30 inches wide. It can also be used at any point on the face of gears or drums up to 30 inches wide and of any diameter. Another convenient application is in the bore of a gun or large bearing. The pendulum weighs 24 kilograms and pivots on a steel ball three millimeters in diameter. Adjustable weights provide for bringing the center of gravity of the pendulum to the center of the ball, while a central weight mounted on a micrometer screw permits of adjusting the length of the pendulum.

The same company has also brought out an operating stand, shown in Fig. 2, for use with the standard 4-kilogram tester. This stand is particularly useful when a number of tests must be made rapidly, and it enables the making of time tests without previous practice on the part of the user. Slight movements of one handle are made (1) to release the table and allow it to rise until the pendulum swings gently on the work; (2) to operate the stop-watch; and (3) to lower the table and replace the pendulum on its three-point support. A ball-pointed diamond can be supplied for

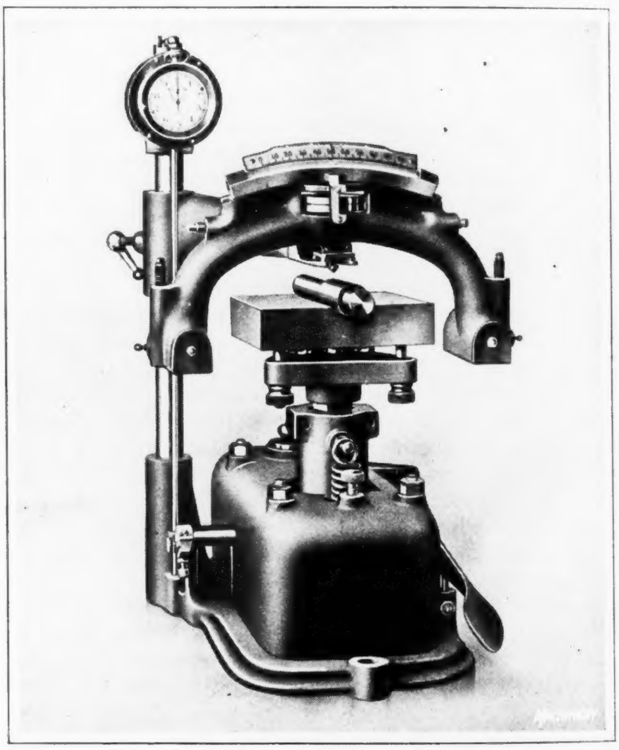


Fig. 2. Operating Stand for the Standard Pendulum Hardness Tester

testing hardened steels. The arm that supports the pendulum can be raised to admit specimens up to 6 inches in diameter or height. The table is mounted on a plate which rests on three leveling screws. Special fixtures may be substituted for the table to facilitate testing irregular shaped work.

KINGSBURY AUTOMATIC SENSITIVE DRILLING MACHINES

A number of improvements have been made in the design of the automatic sensitive drill head for drilling small holes, made by the Kingsbury Mfg. Co., Keene, N. H. The principal feature of this head is that the automatic feed is self-adjusting to meet the variable resistance encountered by the drill in penetrating both work and space. A trip-lever is operated to start one complete machine cycle, but for full automatic operation a latch is simply locked in the disengaged position. The spindle travel is under the control of a cam driven by friction gears, the maximum rate of

Fig. 1. Kingsbury Automatic Sensitive Drilling Machine

travel being usually several times the rate when the drill is penetrating the work. The gears slip during drilling or when resistance is met that is greater than can be overcome by the spring pressure provided. Owing to the method of mounting the cam-levers, this resistance absorbs the spring pressure and leaves the gears in light contact, and consequently subject to little wear. High production is possible owing to the fact that the idle travel of the spindle is at a comparatively rapid rate and that the drill is fed through the work under uniform pressure as fast as conditions permit.

Fig. 1 shows a drill head mounted on a column and base, with a table mounted on the column, for use as a bench machine, but the head may also be used horizontally and in multiple in a number of ways. Fig. 2 shows four heads mounted about a circle for performing several operations on a piece held in a hand-operated indexing fixture.

The drill heads are mounted at various angles for drilling, reaming, countersinking, facing, and threading. The motors are mounted on the individual bases of the heads, the entire units being fastened to adjustable brackets. All trip-levers project to the center where they are actuated simultaneously by a foot-pedal. An automatic clamping attachment may be used to lock the work-table, so as to prevent the operator from indexing the fixture before each head has completed its cycle. Machines are also built with the vertical model arranged in gangs on a stand and with horizontal heads opposed. There is also a three-way design made up of horizontal heads. Special machines can be arranged in many styles.

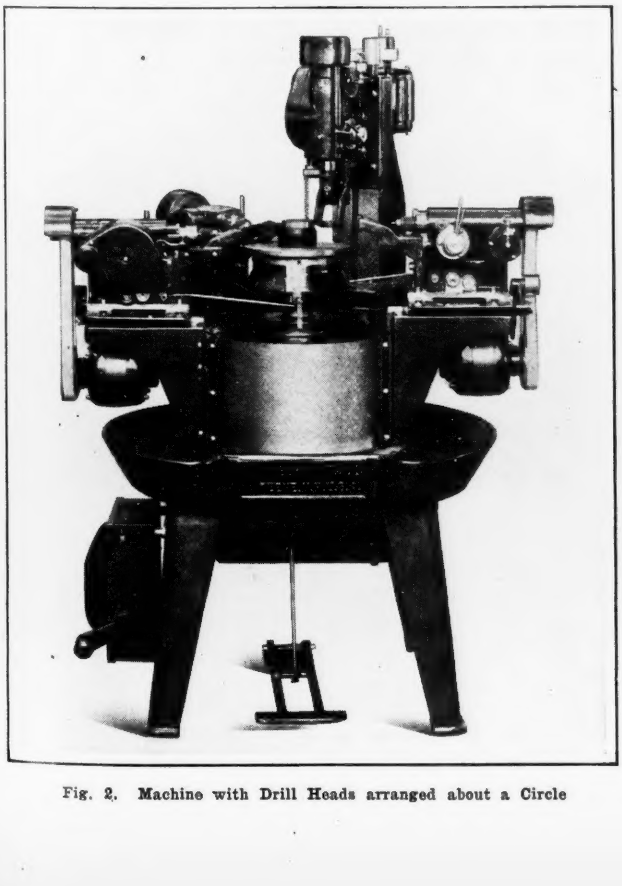
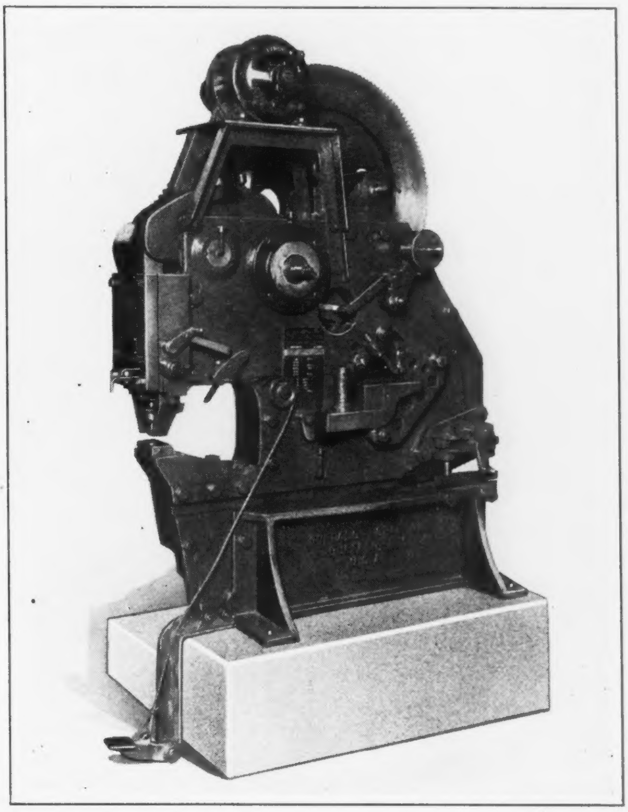


Fig. 2. Machine with Drill Heads arranged about a Circle

BUFFALO UNIVERSAL IRON-WORKER

A No. ½ Junior universal iron-worker has just been brought out by the Buffalo Forge Co., 144 Mortimer St., Buffalo, N. Y. It has the same slitting, shearing, mitering, and bar-cutting capacities as the larger No. 1 machine built by this company, but the framework is more compact, and in some instances the design has been changed slightly.



Buffalo Junior Universal Iron-worker

The new equipment is especially adapted for the smaller sized machine shop where floor space is limited.

The main differences between this machine and the Nos. 1 and 2 machines consist of a shorter throat; a reduced overall frame size; and the provision of a combination die-block which permits of handling structural channels and beams, as well as angles, tees, and flat work. Two bracket supports also replace the one-piece sub-base used with the larger machines. This necessitates a 14-inch foundation to obtain the proper working height of the machine. The ram is of a new design on the punch end, being square, of tool steel, and hardened. In place of the cast-iron bushed connection to the rocker arm, it engages the rocker through a hardened tool-steel seat. The connecting-rod has been dispensed with, the eccentric engaging directly with the walking beam on the punch end.

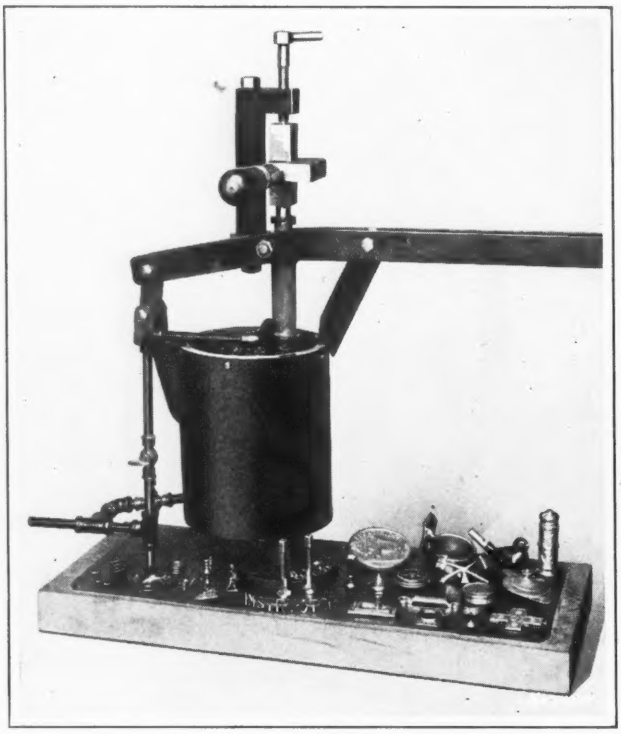
The drive shaft is mounted stationary on the machine, and the flywheel is keyed to the pinion. This, in turn, is equipped with a brass bushing and runs idle on the drive shaft. The slitting shear blades have four cutting edges, as on the larger machines. The new model also incorporates

the interchangeable motor- and pulley-drive arrangement whereby a rapid change can be made from a motor to a pulley drive. The machine will punch structural I-beams and channels from 5 to 15 inches, and shear plates up to 1/2 inch thick and round bars up to 1 5/8 inches, with the standard knives.

BYRD DIE-CASTING MACHINE

A miniature die-casting machine for producing an almost endless variety of small parts such as illustrated, is now built by Robert E. Byrd, 318 Reed St., Erie, Pa. This equipment is known as the "No. 100 Junior" and is intended for use in manufacturing departments, tool-rooms, pattern shops, trade schools, etc. In pattern shops it is useful for casting the letters and numbers attached to patterns.

The top of the piston is a half-ball shape, and the die has a recess to fit this seat, the die being clamped to the top of the piston. The piston and die descend when the lever is depressed, the molten metal being forced up through a hole in the center of the piston in a straight line into the die cavity until the die is full. Then the lever is lifted to the position shown, the die removed, and the casting ejected.



Byrd Miniature Die-casting Machine

The machine is furnished with piping, valves, burners, and one die. The pot is 6 inches in diameter, and holds about 15 pounds of molten metal. About 1 pound of metal can be displaced into the die cavity. The over-all height of the equipment is approximately 22 inches. It is said that from 200 to 300 castings can be produced per hour with this machine.

GIBB ELECTRIC HEATING MACHINES

Machines for heating metals by electric current preparatory to welding, brazing, soldering, punching, forging, bending, or stamping operations are now built in a variety of styles by the Gibb Instrument Co., Bay City, Mich. This method of heating is particularly applicable when only a portion of a piece is to be heated.

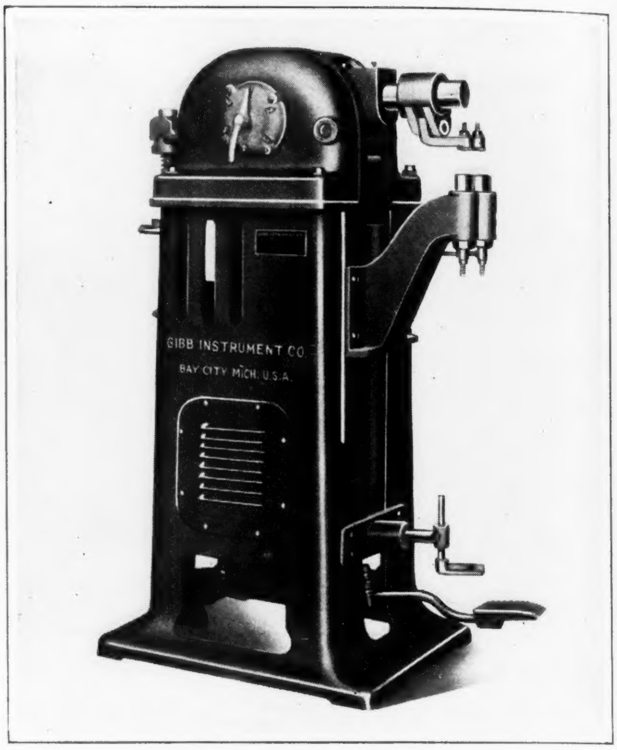


Fig. 1. Gibb Heating Machine used in brazing a Flange to a Tube

Fig. 1 shows a machine designed for brazing a flange to a tube. It is claimed that whereas the brazing previously cost four cents per tube, it is now done at a cost of only 0.6 cent per tube. The machine illustrated in Fig. 2 was designed for heating metallic screen frames so that solder could flow the entire length of the frame into a corner where the metal strip ends meet. The machine accommodates all sizes of frames from 18 to 84 inches, and of varying cross-section. For this purpose the contact changes are made adjustable, and the transformers supplied with 6-inch taps to vary the heat. To prevent a bowing of the frame as it expands when heated, the clamps are pivoted so that they swing outward under the pressure of the expanding metal. The clamps are centrally operated. The heating current is controlled by a clapper type of switch operated by a push-button.

"OPTIMETER"

A device called an "optimeter" is now being introduced on the market by George Scherr, 143 Liberty St., New York City, for checking slip, plug, snap, and other gages, measuring rods and disks, and for inspecting balls and rollers for

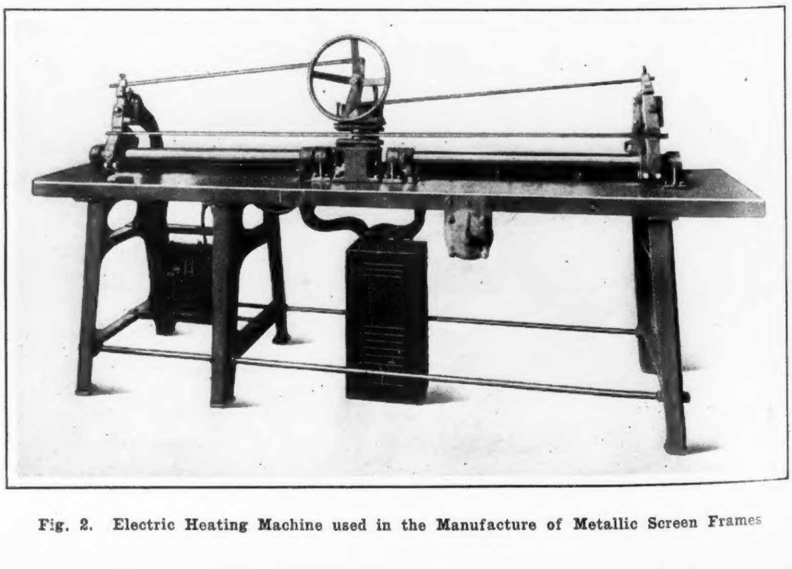


Fig. 2. Electric Heating Machine used in the Manufacture of Metallic Screen Frames

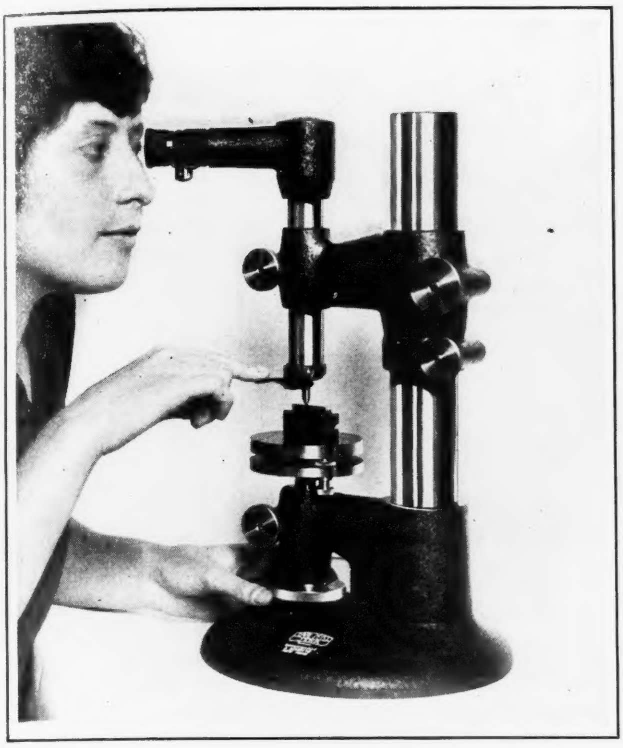


Fig. 1. "Optimeter" designed for checking the Accuracy of Parts by Light Rays

bearings, ball races, wire, spacing washers, etc. The instrument determines the accuracy of parts by means of light rays.

The operating mechanism includes a mirror, which is tilted by the action of a feeler point, and a graduated scale which, by the aid of prisms and lenses, is projected upon the mirror and reflected back into the eye-piece on an enlarged scale. The amount of deviation of the feeler point from the standard position is plainly indicated by a stationary index, along which the image of the scale travels. Each space between the graduations indicates five hundred-thousandths inch, and appears to the eye to be almost 1/16 inch wide. Hence, it is comparatively easy to estimate the accuracy of a part within one hundred-thousandth inch. The range of measurement is 0.0035 inch either side of zero or a total of 0.007 inch.

There is a fine vertical adjustment for the table and also an adjustment for setting the table level, which can be clamped in any position. The feeler is furnished either with a round point for checking flat work, a knife-edge point for cylindrical work, or a flat point for balls. The point is always an agate. The instrument is especially recommended for use with precision gage-blocks. Only 7 or 8 ounces pressure is necessary for the measuring action, and this is applied by a small spring. The "optimeter" may be equipped with special attachments for the different operations, as, for instance, with a horizontal attachment for using it as shown in Fig. 2. The device weighs approximately 50 pounds.

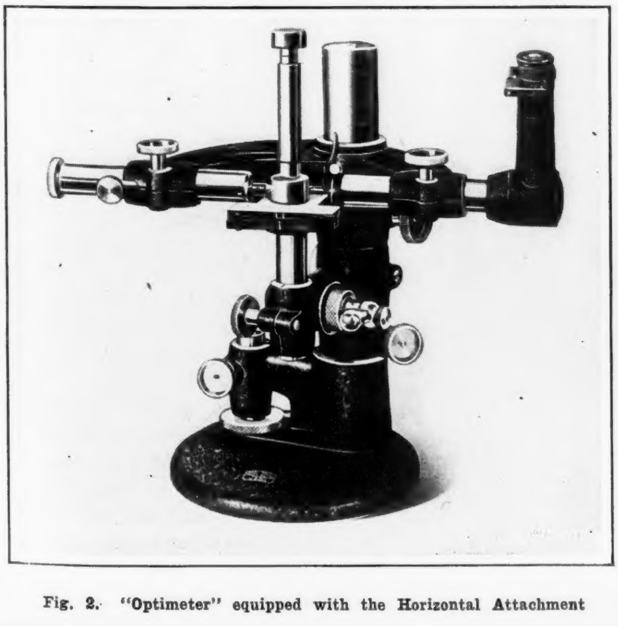
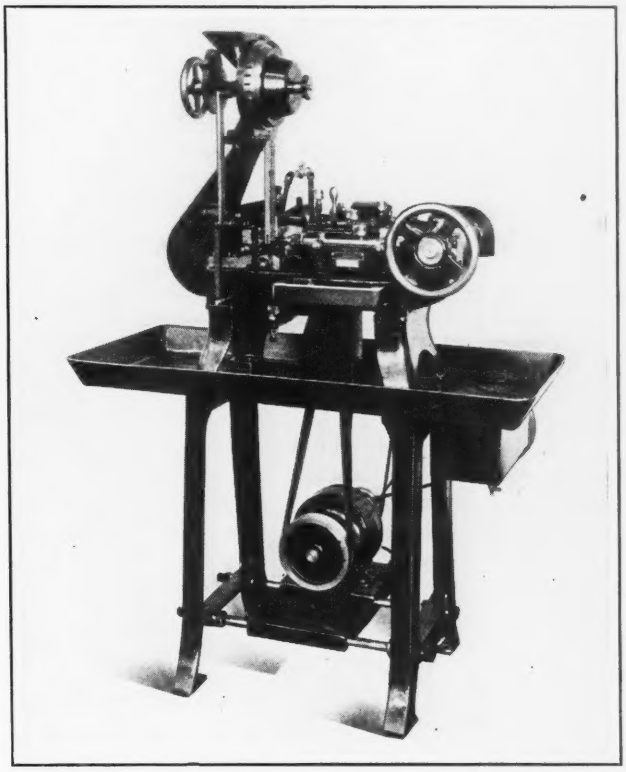


Fig. 2. "Optimeter" equipped with the Horizontal Attachment

WATERBURY FARREL RIVET DRILLING MACHINE

An automatic machine for producing hollow rivets by drilling is now being introduced on the market by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. It is intended that the rivets be produced in a solid-die heading machine with a countersink in the end of the shank to facilitate centralizing the drill point. There are different speed changes to adapt the machine for drilling any metal. One of the principal features is an inspection device which is said to insure a uniform product under all conditions and to eliminate the necessity of further inspection.

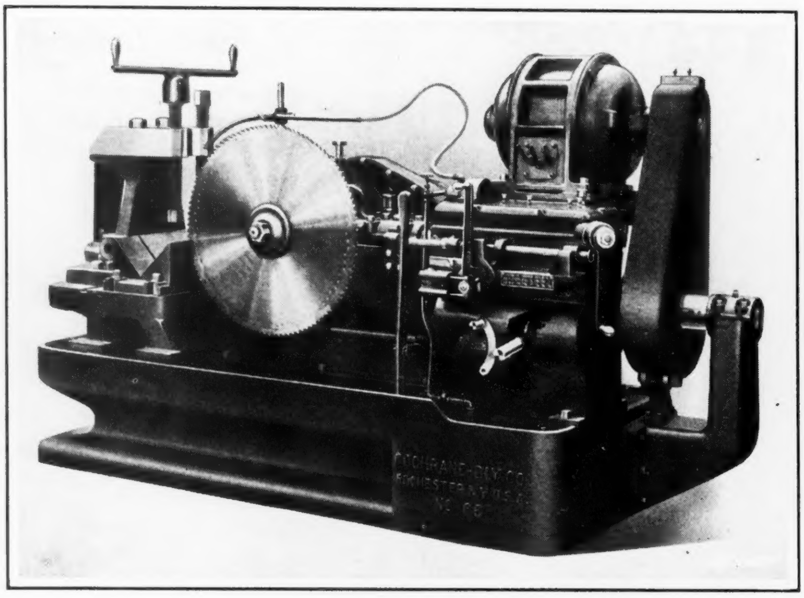


Waterbury Farrel Automatic Machine for drilling Hollow Rivets

The blanks are fed automatically from a drum hopper into a vertical chute from which they are transferred toward the center of the machine by a slide. They are removed from the slide by a vertically operating gripping die which holds them during the drilling. The drilled rivets are next transferred to the inspection device, and finally to a stripper. The transfer slide carries a sheet-steel blade in which there are three semicircular notches for holding the blanks. It is necessary to change this blade for blanks of different diameters. The slide is moved outward by a barrel cam to receive the blanks, but its return movement is spring-actuated and limited by an adjustable stop which locates the rivet in line with the drill.

The rivets are picked up by radial slots in the hopper drum which carries them to the chute, the latter being adjustable to suit the diameter of the work. The blanks leave the chute only when the first notch in the transfer blade is directly under the stack of rivets in the chute. At the lower end of the chute there is a removable plate which extends beyond the inspecting station. This plate backs up the rivet during the drilling and inspecting, and is made to suit the height of the rivet-head.

The inspection slide moves forward with the spindle slide until a pin in the head of the inspection slide enters the drilled hole in the rivet as far as possible without bottoming. In case a drill has broken off in the previously drilled rivet, the inspector pin will strike against it and cause a fulcrum lever to trip and release the main clutch. This device also functions should the hole be drilled shallow. While one rivet is being inspected, another is being drilled and the transfer slide is returning for a third rivet blank. The maximum size rivet that the standard machine will handle is 3/16 by 3/4 inch, and the maximum depth of hole is 1/2 inch. The spindle speed for brass rivets is 7500 revolutions per minute, and for steel rivets, 4100 revolutions per minute. The net weight of the machine is 600 pounds.



Cochrane-Bly H'gh-speed Cold Saw

COCHRANE-BLY HIGH-SPEED COLD SAW

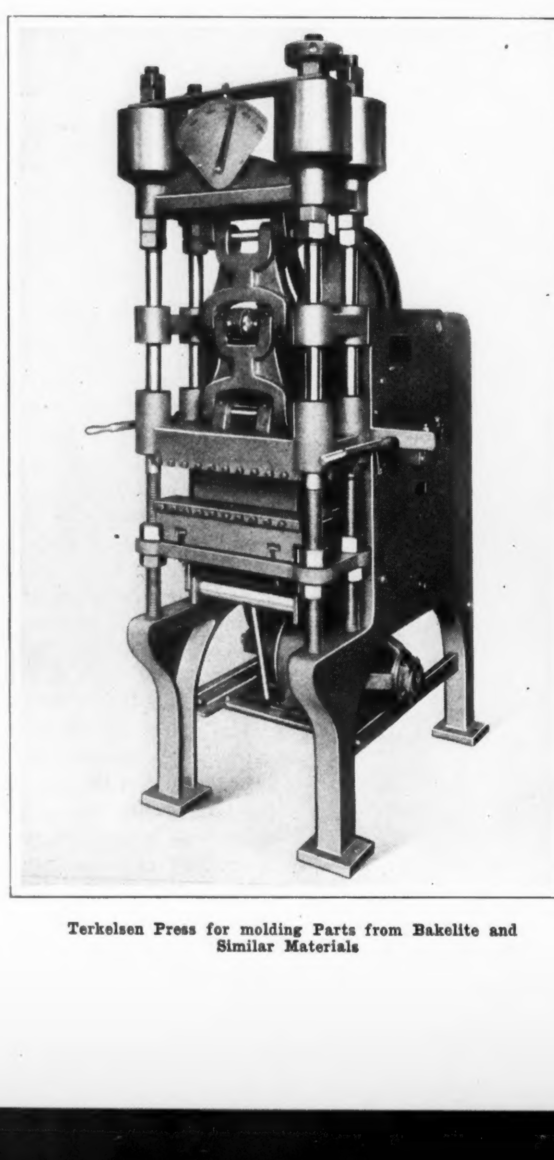
The rapid cutting of bar steel with inserted-tooth saw blades involves a number of problems which the Cochrane-Bly Co., 15 St. James Place, Rochester, N. Y., has endeavored to meet in designing the No. 66 saw here illustrated. To eliminate vibration and chatter, the machine is provided with a saw arbor 5 inches in diameter which is hardened and ground and fitted into a solid bearing. Also, the carriage is cast solid around the ways and fitted with adjustable taper gibs for the full length. A brake is provided for the arbor which absorbs all lost motion in the driving gears and eliminates gear chatter and pounding of the saw teeth when cutting structural angles, tubing, and other light sections where only one tooth is engaged on the work at a time.

The feed-screw is mounted directly in line with the center of the saw arbor and close to the saw blade so that the feed thrust is almost directly in line with the blade resistance. Feed changes ranging from ½ to 2½ inches per minute are quickly made through a sliding gear and tumbler. The carriage has an automatic quick return, being equipped with safety limit stops and adjustable trip stops for the full travel. There is a two-point control from either the front or rear of the machine that operates a friction clutch to start, stop, or reverse the feed. There is also a hand adjustment of the carriage to and from the work.

The machine itself is driven through a friction clutch that is also controlled from either the front or rear and through it the machine can be instantly started and stopped without shifting belts or starting and stopping the motor. The driving gears are fully enclosed in the rear of the saw carriage when they run in a bath of oil. Sliding gears on the worm-shaft give three cutting speeds of 30, 40, and 50 feet per minute. The double-screw vise shown is standard equipment, but the machine can also be furnished with a 60-degree V-block and a three-screw vise to permit the multiple cutting of small round bars. A hand-operated device (not illustrated) is supplied to feed the bar and automatically measure the length of piece to be cut. The motor drive shown is through a silent chain. This machine has a capacity for cutting round bars up to 10 inches, square bars up to 9 inches, I-beams up to 12 inches, and rectangular sections up to 8 by 12 inches. The weight is about 7000 pounds.

TERKELSEN MOLDING PRESS

A press that is operated entirely by mechanical means for molding parts from bakelite, condensite, redmanol, and other synthetic compounds, has been developed by the Terkelsen Machine Co., Terkelsen Bldg., 326 A St., Boston, Mass. In this machine springs of special construction are employed to retain the pressure necessary while "curing" the work, and an adjustment provides for obtaining any desired pressure. The mechanical operation is said to permit rapid production. The machine is driven by a motor through compound gearing, a cam, and a toggle. Either closed or open molding may be performed.



Terkelsen Press for molding Parts from Bakelite and Similar Materials

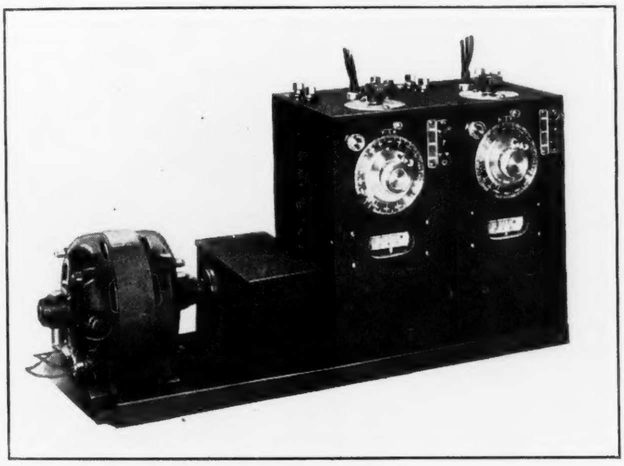
After the mold has been loaded with powder or synthetic compound, as the case may be, the operator places his left hand on the safety release lever and his right hand on the starting lever to throw in the clutch. The upper die-block moves downward rapidly to within ¼ inch of the closing point and then slowly until closed, at which time the pressure retaining springs start to function. The clutch is then thrown out automatically and full pressure obtained without any power consumption. When the work has been "cured," the operator puts his left hand on the safety release lever and his right hand on the starting lever. As this is done, the pressure retaining springs release and the upper

die-block moves rapidly upward. At the end of this movement, the clutch is thrown out automatically, and the work ejected either automatically or by a hand lift, as preferred. For hot-molded materials, heating and cooling facilities are necessary. This press is built in a number of sizes, the 50-ton press being operated by a two horsepower motor.

WILSON-MAEULEN AUTOMATIC TEMPERATURE CONTROL

A new automatic temperature control equipment that employs the potentiometer method has been placed on the market by the Wilson-Maeulen Co., 383 Concord Ave., New York City. This equipment is designed for use with oil, gas, electric, or steam-heated furnaces, and will operate with standard power valves of the motor-driven, solenoid, or hydraulic types. The equipment consists of three standard interchangeable units.

The power unit is driven by a 1/4-horsepower motor which may be furnished for either alternating or direct current. A reduction gear system which runs in oil transmits the power to the control unit at the desired speed. The control unit is actuated by a thermo-couple circuit which uses either base or Noble metal thermo-couples. The galvanometer and all mechanical parts are standard and interchangeable. A temperature dial 12 inches in circumference provides a large scale for making close-temperature settings.



Wilson-Maeulen Automatic Temperature Control for Furnaces

The unit feature of the equipment makes it convenient to build up a multiple control capacity by adding control units up to six to the same power unit. Control units may be added or removed without disturbing the balance of the equipment. The standard cycle of operation is ten seconds, but control units can be supplied for either five-, ten-, or twenty-second cycles. A wide variety of temperature ranges are furnished for many kinds of thermo-couples.

HART & HEGEMAN AUTOMATIC TAPPING MACHINE

An automatic machine intended for use in factories where large quantities of small parts are tapped, has recently been placed on the market by the Hart & Hegeman Mfg. Co., 342 Capitol Ave., Hartford, Conn. The machine is particularly adapted for handling sheet-metal pieces that are difficult to place in jigs. Three speeds are obtainable for the spindle through the cone pulley, these speeds ordinarily being 45, 65, and 85 strokes per minute. This means that a similar number of holes can be tapped in the same time. However, with brass pieces the speed can be increased. Collets are furnished to hold taps up to 1/4 inch in diameter.

The spindle is driven by a large spur gear which is wide enough to allow the up-and-down travel of the upper spindle pinion. This spur gear is keyed to a shaft which also has keyed to it a bevel pinion driven by a bevel gear segment on the left-hand side of the machine. The segment, in turn, is oscillated by a crank and connecting-rod. The upper tap driving spindle is threaded at the lower end to fit a bronze part which also serves as a bearing for the spindle. When the spindle is rotated, the threaded part acts as a lead-screw and advances or withdraws the spindle according to the direction in which the spindle is turned. The tap is carried by a second spindle in line with the first and driven from the first by means of a square sleeve having a telescoping connection with the tap-holding sleeve. Pressure for starting the tap into the work is supplied by a compression spring. Should the tap strike an obstruction, it would compress the spring and be released for the next hole.

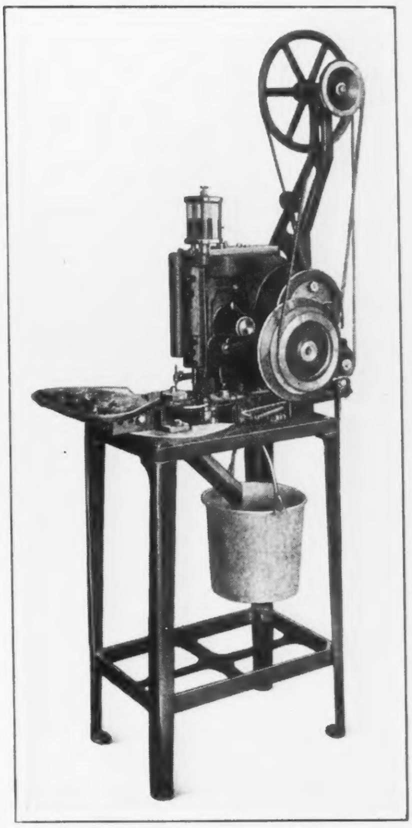


Fig. 1. Hart & Hegeman Automatic Tapping Machine

The machine is arranged to use dials of three different sizes to suit the work. The dial is rotated by a pawl which engages notches milled into its periphery, the number and spacing of the notches depending upon the size of the work and the location of the holes. Two or more holes of the same size can usually be tapped in a piece. There is a knockout mechanism on the left-hand side of the machine which

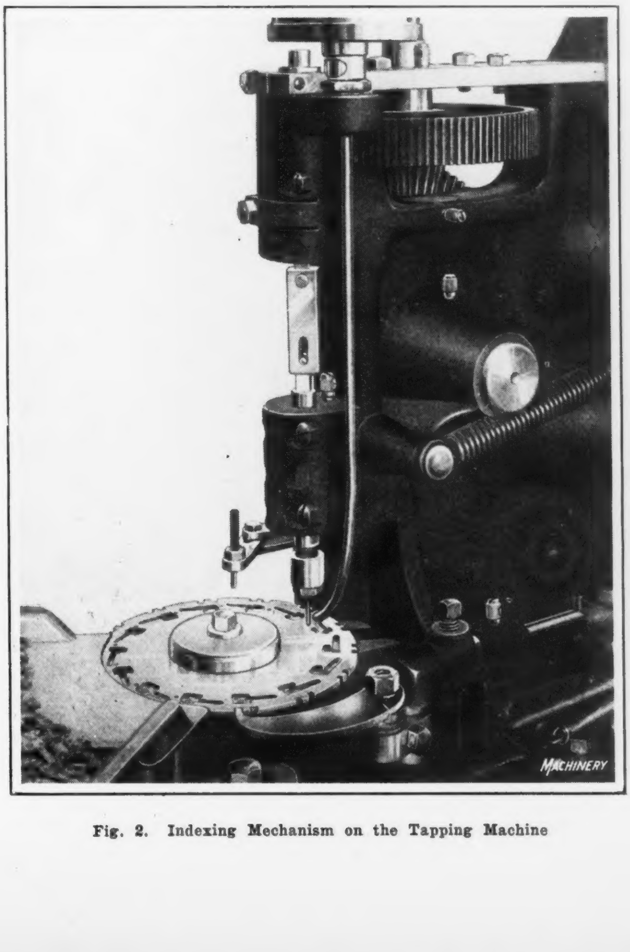


Fig. 2. Indexing Mechanism on the Tapping Machine

is operated by the bevel-gear segment to push the work through the feeding dial when the operation is completed. The knock-out finger is forced down by a spring, which compresses in case the finger strikes the dial and thus prevents damage. A safety clutch stops the tapping spindle if for any reason the dial does not index properly. This machine is built in both bench and floor types.

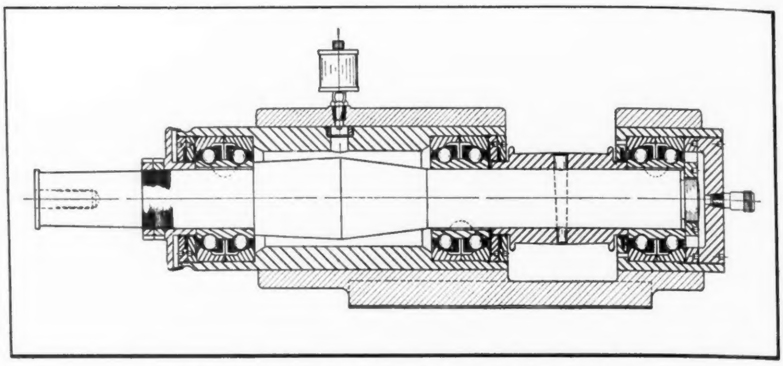
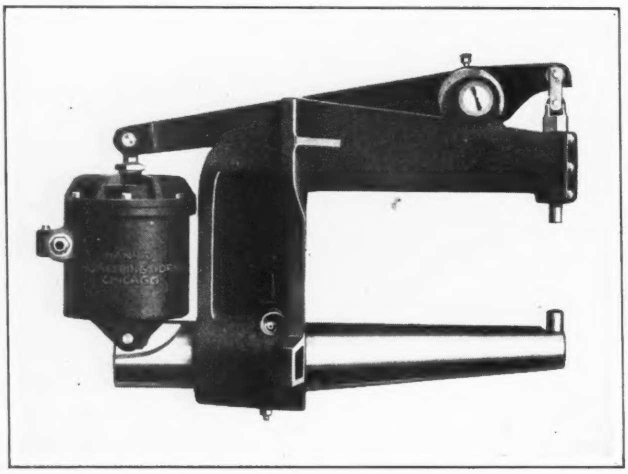


Fig. 2. Sectional View of the Internal Grinding Spindle

HANNA RIVETING MACHINE

A new riveting machine designed for light work has recently been placed on the market by the Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. This equipment has proved particularly useful in the manufacture of domestic heating-furnace doors. In this work it is employed to rivet a sheet-steel outer shell to the edge of the firing door. The lower



Hanna Light-work Riveting Machine

or dead stake is made of forged alloy steel and heat-treated. It is 6½ inches in diameter at the throat and tapers to 4 inches in diameter at one end.

Foot brackets are cast on the frame to permit mounting the riveter in a stationary position with the reach vertical, the dies horizontal and the cylinder down. This machine has a capacity for driving ⅜-inch rivets hot and ¼-inch rivets cold. It has a reach of 24 inches, a gap of 13 inches, and a cylinder diameter of 9¼ inches. A pressure of approximately 10 tons is exerted on the dies with an air pressure of 100 pounds per square inch. The piston stroke is 7 9/16 inches, and the die stroke, 1⅞ inches. The total weight of the machine is about 1180 pounds.

EX-CELL-O GRINDING SPINDLE

A new type of internal grinding spindle is being manufactured by the Ex-Cell-O Tool & Mfg. Co., 1469 E. Grand Blvd., Detroit, Mich., for application to Heald internal grinding machines. As shown in Fig. 2, this spindle is equipped with Ex-Cell-O high-speed ball bearings of the type described in the present number of MACHINERY. The spindle has a long support at the front for the grinding wheel, and a short support at the rear for the pulley.

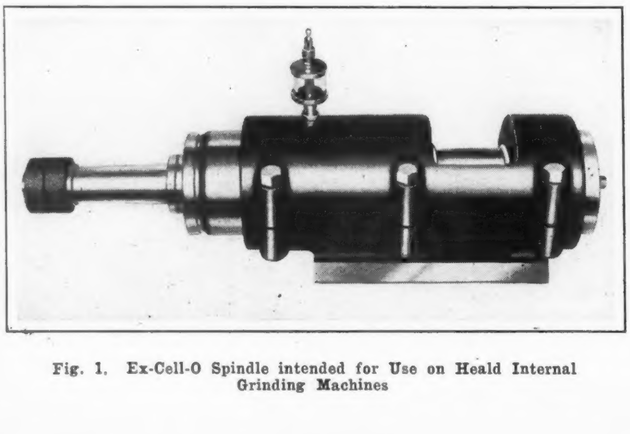


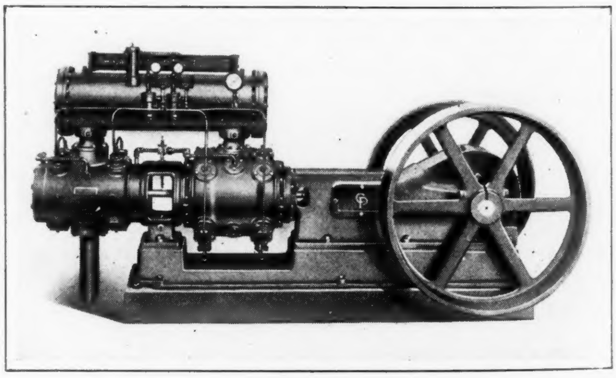
Fig. 1. Ex-Cell-O Spindle intended for Use on Heald Internal Grinding Machines

A number of advantages are claimed for this spindle, one of which is that a higher finish is obtained on the work due to the absorption of belt vibration. The thrust is divided between the front and rear bearings, which is especially important in face or shoulder grinding. Longer life is also claimed, due to the distribution of the belt load over an additional bearing and housing.

CHICAGO PNEUMATIC TWO-STAGE COMPRESSOR

A straight-line two-stage air compressor which has a piston displacement of 360 cubic feet of free air per minute when driven at 275 revolutions per minute, is one of the new products of the Chicago Pneumatic Tool Co., 6 E. 44th St., New York City. Air pressures ranging up to 125 pounds per square inch are obtainable. This class N-CTB compressor is adapted to being driven by belt or by a synchronous motor with the rotor mounted directly on the compressor crankshaft.

Tandem construction is used in this unit, with the low-pressure cylinder placed next to the frame and the high-pressure cylinder connected to the low-pressure cylinder by



Chicago Pneumatic Two-stage Compressor

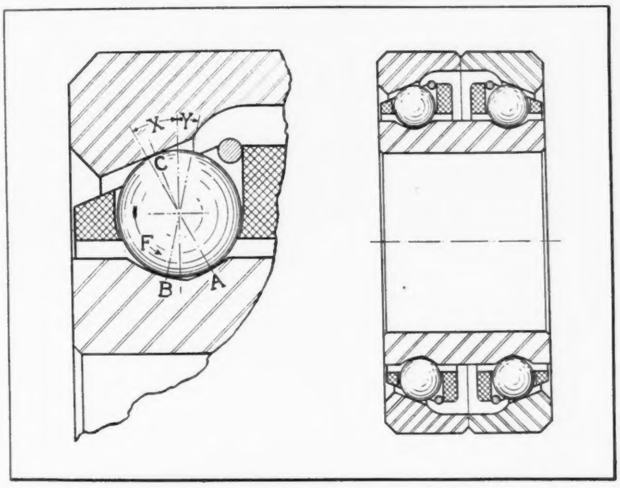
means of a tandem piece, through which the piston-rod stuffing-boxes are easily accessible. The intercooler is mounted above the two cylinders where it may be conveniently cleaned from either end. The whole unit is mounted on a sub-base, which gives the desired rigidity and makes the outfit portable for use in semi-permanent installations.

In designing this equipment, special attention was directed toward making adjustments easy, which is especially true of the wedge adjustment for the connecting-rod bearings. Regulation of the volume of air and its pressure is entirely automatic, a three-step capacity regulation being regularly furnished in which two differential unloaders operating automatic unloading Simplate inlet valves, cause the compressor to operate at full, half, and no load, accord-

ing to the air demand. When the demand is fairly constant for periods, with intervening periods in which there is a slight or no demand, and the compressor is driven by a motor, operation under an automatic start-and-stop control can be employed.

EX-CELL-O HIGH-SPEED BALL BEARING

A combined radial and thrust ball bearing, intended for operation at speeds up to 50,000 revolutions per minute, has recently been brought out by the Ex-Cell-O Tool & Mfg. Co., 1469 E. Grand Blvd., Detroit, Mich. From the sectional view in the illustration, it will be seen that as angle X is greater than angle Y, the point of contact A is farther from the rotating axis than point B. Hence the ball revolves faster at A than at B, which causes it to spin about point C in the direction of arrow F as well as in the direction in which the race travels. This construction is said to eliminate the wearing of flat spots or tracks on the ball. The bearing is so designed that after becoming worn it can be salvaged by grinding the faces of the outer races. If excessively worn or pitted, the raceways can be reground. Bakelite ball separators are used.



Ex-Cell-O Ball Bearing intended for Use at Speeds up to 50,000 Revolutions per Minute

BROWN & SHARPE THREAD-TOOL GAGE AND INSIDE MICROMETER

Three thread-tool gages with measuring surfaces ground to 29, 55, and 60 degrees to cover Acme, Whitworth, and U. S. standard threads, respectively, have been added to the line of tools made by the Brown & Sharpe Mfg. Co., Providence, R. I. With these No. 577 gages it is possible to measure or check thread-cutting tools, from those having a sharp vee to those having a 1-inch flat. In setting the gage, a plug gage or a piece of stock of the width of flat required is inserted in the opening at the top that corresponds to the flat at the top of the angular opening.

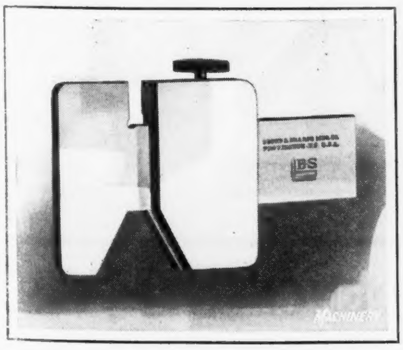


Fig. 1. Brown & Sharpe Thread-tool Gage

The range of pitches which a single tool covers, taking, for example, the U. S. standard thread, compared with the number of slot gages necessary to cover all pitches, makes it a valuable asset in the shop. The gage with the 29-degree angle can be used for checking tools for both 29-degree screw or worm threads. The measuring surfaces of all gages are hardened and ground.

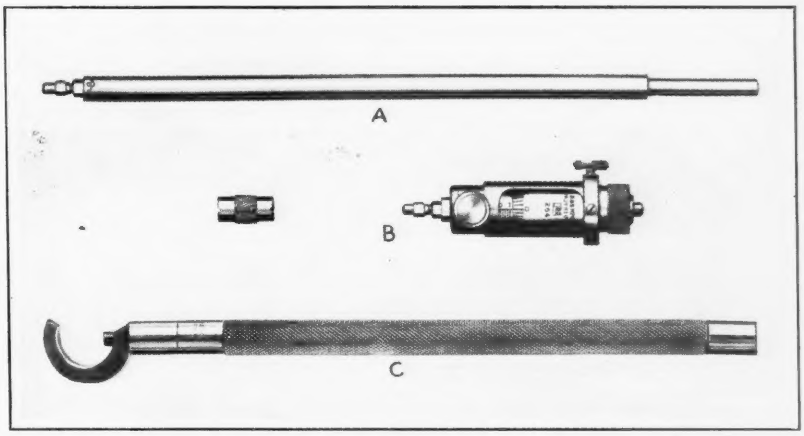
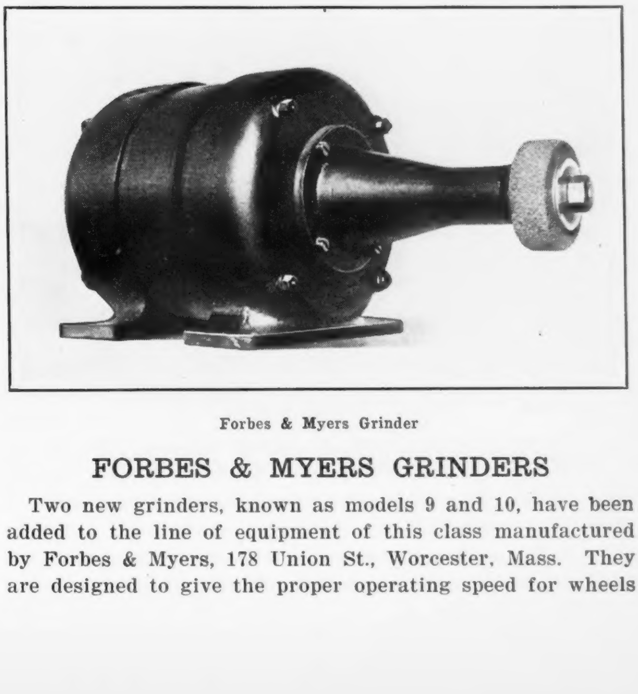


Fig. 2. Inside Micrometer with Locking Device and Long Handle

The same company is also introducing on the market the No. 264 inside micrometer illustrated in Fig. 2 which has a measurement range from 2 to 8 inches by thousandths of an inch. The instrument consists of a micrometer head B which has a ½-inch measuring screw, six rods A of various lengths, and one spacing collar. The shoulder on the rods fits into the micrometer head, and when the rod is in position with the shoulder against the head, the first half of the inch can be measured—for instance, from 3 to 3½ inches. With the spacing collar in place on the rod, the last half of the inch (from 3½ to 4 inches) can be measured.

The principal feature of this micrometer is a clamping device. The outer shell of the micrometer is split in two places, and the metal that projects between the two slots forms a shoe which is forced against the micrometer thimble by the thumb-screw. Hence the thimble may be locked at any reading. The measuring end of the rods is hardened and so designed that it is possible to adjust it.

At C in Fig. 2 is shown a handle designed for use with this micrometer. By means of this handle, the micrometer can be inserted in small holes a greater distance than by the hand alone, and accurate measurements made. The handle consists of a hook provided with an adjustable brass plug which is tightened against the micrometer head by turning the knurled handle. The hook fits snugly around the body of the micrometer and the brass plug is soft so as not to mar the micrometer shell.



Forbes & Myers Grinder

FORBES & MYERS GRINDERS

Two new grinders, known as models 9 and 10, have been added to the line of equipment of this class manufactured by Forbes & Myers, 178 Union St., Worcester, Mass. They are designed to give the proper operating speed for wheels

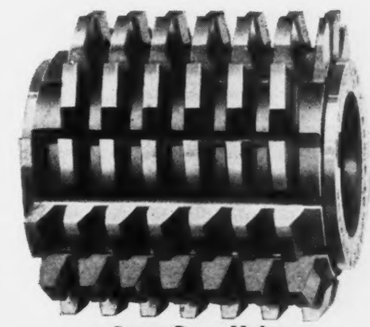
Another Economical Combination

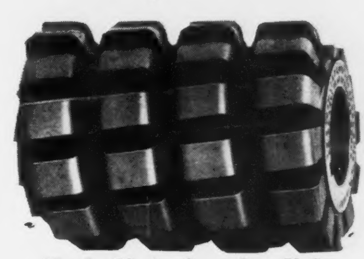
Brown & Sharpe Hobs
and Gear Hobbing Machines

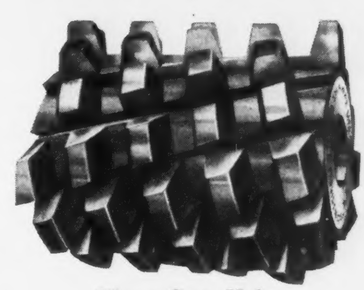
Due to their rugged construction Brown & Sharpe Gear Hobbing Machines will cut quiet running gears at a rapid rate. Add to these powerful machines, the accurate, clean cutting qualities of Brown & Sharpe Hobs and you have a production combination that cannot be beaten.

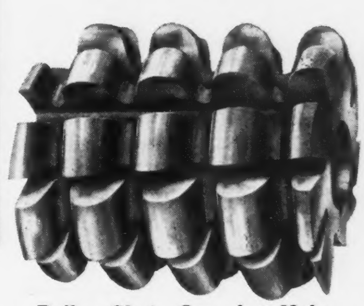
These hobs cut as freely as standard milling cutters and they can be sharpened without changing their form. Great care in heat-treating and the use of only the best steel obtainable are responsible for the remarkable way these hobs maintain their cutting qualities and for the big production they give between sharpenings.

Catalog No. 29 lists our complete line of hobs together with many other types of milling cutters. Send for a copy of this catalog today.


Spur Gear Hobs


Block Chain Sprocket Hobs


Worm Gear Hobs


Roller Chain Sprocket Hobs

Brown & Sharpe Hobs are made to cut spur, spiral or helical gears, sprockets and splined shafts. We also are in a position to make any form of hob for special purposes.

For the best results try using Ground Hobs. They are ground on the form eliminating slight hardening distortions. They also present a very keen cutting edge to the work.

SHARPE

Brown & Sharpe have been making cutters for the past 60 years. This experience in cutting and heat treating milling cutters and hobs should mean something to you.

Machine Tools, Machinists' Tools, Cutters and Hobs

from 2 to 4½ inches in diameter. The motor is of the induction type, of ¾ horsepower capacity. Motors can be furnished with speeds of 5400 and 7200 revolutions per minute on 60-cycle current, or 2250 and 3000 revolutions per minute on 25-cycle current. The higher speeds are suitable for wheels 3 and 4½ inches in diameter respectively, resulting in surface speeds of 5600 feet per minute. The speed of 7200 revolutions per minute is desirable for wheels down to 2 inches in diameter, and gives a fair degree of satisfaction with wheels even smaller. In order to avoid interference with the motor, the wheels are spaced 7 inches from this member, the spindle being supported next to the wheel by a hollow arm.

REED-PRENTICE HOLLOW-SPINDLE LATHE

A hollow-spindle lathe recently developed by the Reed-Prentice Co., Worcester, Mass., has a special enlarged hollow spindle construction which permits the telescoping of work inside of the headstock, so that the extended portion of the work may be completely machined while using a chuck drive close to the operating position. The ruggedness of construction allows extra heavy series of cuts to be taken at one time, both with the front and rear tools, as in the machining of crankshafts, armature shafts, and similar work in which it is of decided advantage to reduce the amount of overhang to a minimum.

The headstock is of box construction, and has an adjustable center for accommodating various lengths of work. The hole in the spindle is of sufficient size to allow all standard makes of automobile crankshafts to be "telescoped" within it. In machining a crankshaft, the latter is supported between the head- and tail-centers and is driven by a special chuck which grips the crankpin directly adjacent to the portion being machined. By the use of a special rear slide construction, the burden of the cutting is taken with the down pressure on the front block, and both the front and rear tools operate simultaneously. The chuck is arranged with a large opening which permits the work to be loaded readily, while a sliding bell-mouth sleeve inside the hollow spindle locates the work on the headstock center. The work is telescoped in the hollow spindle just far enough for each machining position, to permit driving close to the portion being machined. The rear tools perform the turning operation, while the front tools perform the facing.

The drive is through a disk clutch and brake located at the rear of the head and operated by a hand-lever at the front of the headstock. The disk clutch and brake provides for instantaneous starting and stopping of the spindle. The headstock gears are hardened steel of the herringbone type, providing for smooth power transmission to the spindle. The gear shafts in the headstock, with the exception of the spindle, run in ball bearings. The headstock can be furnished with either a belt or a motor drive. The illustration shows it arranged for herringbone gear connected motor drive with all gears running on ball bearings. The motors used range from 5 to 20 horsepower, depending upon the class of work.

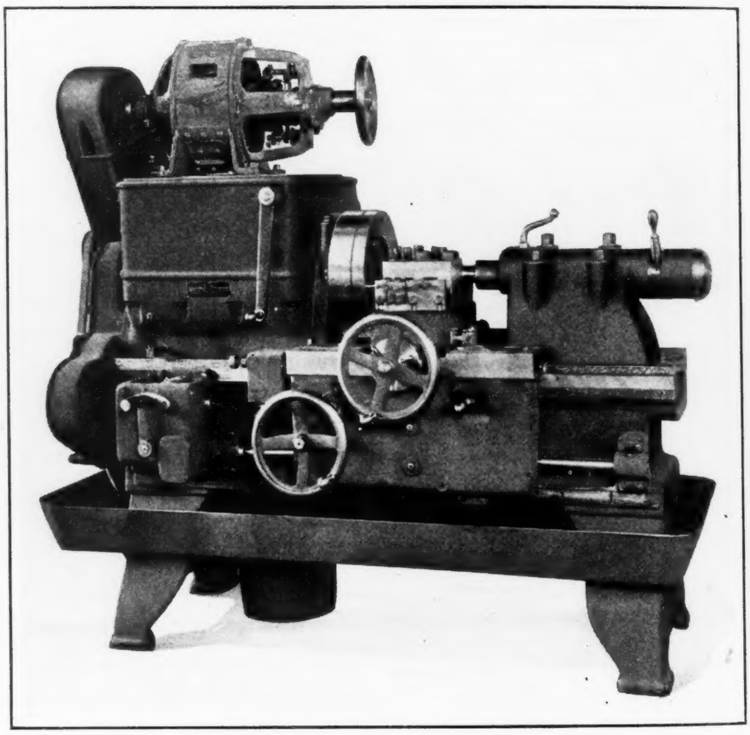
The lathe is entirely automatic in its cycle of operation, including the control of diameters and length of the work. All handles are centrally located. The cam tailstock provides for quick withdrawal of the tail-center, as well as fine adjustment of the center in the work. The carriage is supported on a right-angle bearing inside the bed, directly under the front tools. The apron is arranged with independent power longitudinal and cross feed, either of which may be engaged separately. Both the longitudinal and cross feeds are automatically operated and tripped in both directions. By the use of positive bed and cross stops, accurate positioning of the tools can be obtained.

The facing and chamfering operations are usually effected through the use of the Reed-Prentice patented back-arm attachment provided with sensitive worm adjustment for locating the tools relative to the work. The feed-box gives four feeds, and by compounding the standard gears constituting the end works, three additional feeds may be obtained. The entire headstock is lubricated through a splash system, and a sight-feed oiler shows the level of the oil at all times. Various sizes and types of tool-holders and drivers can be furnished to suit the large variety of work for which the machine is adaptable.

* * *

NEW MACHINERY AND TOOLS NOTES

Gear Burring Machine: Dynamic Gear Burring Machine Co., 14031 Westlawn Blvd., Detroit, Mich. A machine designed for removing burrs produced on the ends of gear teeth during the hobbing or cutting operation. This is accomplished by means of a burnishing tool and a shearing tool. The burnisher resembles a hob without the teeth gashed and meshes with the gear. This tool causes the burrs to project from the ends of the teeth at an angle which permits the stationary shearing tool to cut them off.



Reed-Prentice Hollow-spindle Lathe

Helve Hammer: Sutton-Abramsen Engineering Co., Park Bldg., Pittsburg, Pa. An upright cushioned helve hammer designed to strike either a heavy or light blow at fast or slow speed. The end of the helve enters loosely into the top of the ram in such a way that a compensating device is not required. Elasticity of the ram overthrow is obtained by the fulcrum bearings of the helve. Rubber cushions are placed above and below this bearing, and in combination with other rubber cushions at the rear of the helve, absorb the concussion of the blow and are said to add to its force.

Cylinder Boring Machine: Defiance Machine Works, Defiance, Ohio. An eight-spindle cylinder boring machine with fixed center distances, which is adapted for rough-boring and semi-finishing or reaming cylinders of any number of bores. In operation, the table automatically feeds the work to the boring tools, and when the cut is completed, it automatically reverses to a fast travel to return to the loading position, where it stops and remains stationary until after the machine has been reloaded. Two jack-screws raise and lower the table. The machine weighs approximately 15,500 pounds, and is driven by a motor of from 15 to 25 horsepower.

MACHINERY'S NEW HANDBOOK

MACHINERY'S HANDBOOK. Revised and enlarged edition. 1592 pages, 4½ by 7 inches. Published by THE INDUSTRIAL PRESS, 148 Lafayette St., New York City. Price, $6.

A little over ten years ago the first edition of MACHINERY'S HANDBOOK made its appearance. Since that time minor revisions have been made in the various editions, comprising, in all, 150,000 copies, but no extensive revision and enlargement of the work was undertaken until the present, or sixth edition, which contains 192 more pages than the last edition. Owing to the use of thin paper, the new work is no bulkier than previous editions.

While the new edition contains 192 more pages than the former, a great deal of the material in the old edition that has become obsolete in the last ten years has been eliminated, so that the new edition has 230 pages of new matter, and 55 pages that are entirely revised exclusive of the new material. Ninety-seven tables are added, 77 new illustrations supplement text and tabular matter, and 35 tables of the early editions have been completely revised.

Among the important revisions and additions may be mentioned the following: The section on screw thread systems has been expanded by the addition of 18 tables with explanatory text; new helical spring tables are included, giving load capacities and corresponding amounts of deflection for springs made from different sizes of wire; the section on jigs and fixtures has been greatly strengthened by the addition of 8 tables giving proportions of jig and fixture details suitable for standardization; angular and compound indexing is dealt with in 9 pages of tables; a 7-page sine-bar table with dimensions for setting a sine-bar to any angle from 1 minute up to 56 degrees, varying by minutes is added; new speed and feed data for turning, milling, drilling, and other machine shop operations is included; a 10-page section explains the use of the slide-rule, accompanied by eight large-scale illustrations showing exactly how adjustments are made for different conditions. Among the other new material is that relating to the heat-treatment of steel, covering both carbon and alloy steels; an enlarged section on limits and tolerances; application of welding and cutting torches; new material on electric welding; revised section on motor drives for machine tools; new tables covering ultimate loads on columns for different ratios of slenderness; Rankine's and Euler's column formulas in convenient arrangement; permissible working stresses; critical speed formulas; roller bearing load table; and additional data on gearing, including a 24-page table containing the most complete data for solving unusual gear-ratio problems quickly, that has ever been compiled. This table covers nearly 5000 different ratios with over 12,000,000 four-gear combinations.

In addition, there are many important changes in the material found in the former HANDBOOK in the sections on strength of materials, riveting and riveted joints; clutches and couplings; power transmissions; bolts and nuts; automatic screw machine practice; thread rolling; tapping and thread cutting; cutting oils and compounds; measuring instruments and gaging methods; grinding, polishing, and lapping; taps and threading dies; iron and steel; forging; cement and concrete; composition of alloys; pipes and pipe fittings; and plant appraisal.

The new revised and enlarged edition of MACHINERY'S HANDBOOK is bound in dark green Atholeather, stamped in gold. A thumb-index is provided, dividing the book into fourteen principal sections, and permitting each section to be referred to quickly. The principal sections are as follows: Logarithmic tables; trigonometrical tables; mechanics; strength of materials; gearing; bolts and screws; speeds and feeds; fits, tolerances and limits; screw threads; small tools; heat-treatment; pipe fittings; weights and measures; and the index.

* * *

MEETING AND EXHIBIT OF THE AMERICAN SOCIETY FOR STEEL TREATING

The sixth annual convention and exhibit of the American Society for Steel Treating was held in Boston, September 22 to 26, the headquarters of the convention being at the Copley Plaza Hotel and the exhibition being held at the Commonwealth Pier. The exhibit was one of the largest ever held of machine shop and heat-treatment equipment. More than eighty machine tool and small tool manufacturers were represented from all over the country; and, in addition, a great number of the steel companies and concerns manufacturing furnaces and other heat-treating equipment had exhibits.

The technical sessions were held partly at the Copley Plaza Hotel and partly at the Commonwealth Pier. There were two technical sessions each day during the five meeting days, and altogether over forty papers were presented on practically all phases of steel and its heat-treatment. The papers were grouped as far as possible so as to deal with similar subjects in the same session. Thus, for example, one session dealt with salt baths as heating media, another with laboratory methods and microstructure of steel, and another with commercial heat-treatment, including automobile parts, dies, and tool steel in general. One session covered hardness testing methods, and one dealt with metallurgical education. Considerable attention was given to stainless iron and steel, and the metallurgist found much of interest in the papers relating specifically to the structure of steels of different kinds.

In connection with the meeting, a number of plants in Boston and vicinity were visited. Tuesday afternoon, September 23, an excursion was made to the Waltham Watch Co.; on September 24, the General Electric Co. in Lynn was visited; and in the afternoon of September 26, a tour was made that included Harvard University, Massachusetts Institute of Technology, and the Navy Yard. A large textile mill in Salem, Mass., the Naumkeag Mfg. Co. was also visited, as well as the Thomas G. Plant Co., one of the largest shoe manufacturing concerns in New England. The social side of the convention was also well looked after, the annual smoker being held Tuesday evening, and the annual banquet Thursday night.

* * *

PERSONALS

PHILLIPS N. CASE, formerly advertising manager of the Fafnir Bearing Co., New Britain, Conn., has been succeeded by STANLEY COOPER.

FRANK A. WILCH, who has been associated with the Cleveland office of the Triumph Electric Co., Cincinnati, Ohio, has been placed in charge of the Cleveland territory, succeeding Edward S. Ford.

D. K. RIVAS has been appointed manager of the New York office of the Wagner Electric Corporation, 50 Church St., New York City, manufacturer of motors, transformers, and automotive starting, lighting, and ignition equipment.

CHARLES L. WINN has joined the Mossberg Pressed Steel Corporation, Attleboro, Mass., as sales executive. Mr. Winn is a graduate of the Lowell Textile School, and has had both practical and technical training in the industry.

NELSON LITTELL, for several years an examiner in the metallurgical and chemical division of the Patent Office, has recently become a member of the firm of Hammond & Littell, patent lawyers, 110 E. 42nd St., New York City.

F. J. DELIMA has been appointed agent in Canada for the sale of the line of electric welding and electric heating machines made by the Gibb Instrument Co., of Bay City, Mich. Mr. DeLima's headquarters are in the Keefer Building, Montreal.

DAVID E. DRAKE, dean of the sales department of the Westinghouse Electric & Mfg. Co., with which company he has been connected for thirty-four years, has retired. Mr. Drake has been associated with the electrical industry for over fifty years. He will make his future home in San Diego, Cal.

JOSEPH F. PFLUM who has been manager of the Cincinnati branch of the Heald Machine Co., Worcester, Mass., for many years, will now also have charge of the Cleveland territory. Mr. Pflum will be located in the Cleveland Discount Building, Room 614, Cleveland, Ohio. R. A. St. John will assist Mr. Pflum in sales and service work at the Cleveland office.

E. G. RIPPEL, founder of the Buffalo Foundry & Machine Co., and for many years associated with that concern, has recently become president of the Chemical & Vacuum Machinery Co., Inc., Buffalo, N. Y. CHARLES O. LAVETT, for many years engineer in charge of tests and field erection with the Buffalo Foundry & Machine Co., is now manager of the Chemical & Vacuum Machinery Co., Inc.

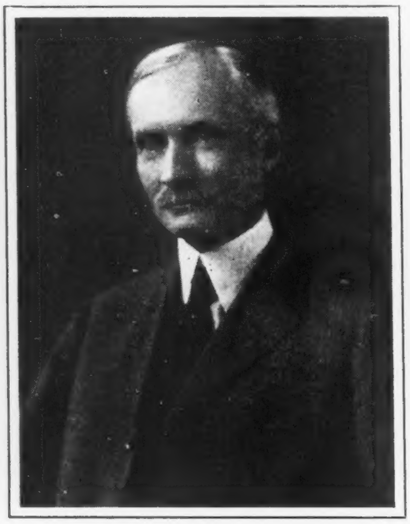
MARTIN G. SPERZEL, sales manager of the Royersford Foundry & Machine Co., Royersford, Pa., has been elected a director of the company and been made vice-president and general manager. The sale of all machine tools, shearing machines, punching machines, and tumbling barrels, formerly handled at the main office of the company, has now been turned over to the Philadelphia office of which Mr. Sperzel is the head.

HARRY F. STIMPSON, president and general manager of Wheelock, Lovejoy & Co., Inc., Cambridge, Mass., has resigned to devote his time to other interests. A. ORAM FULTON, who has been associated with Mr. Stimpson for the last fifteen years and has been vice-president of the company since its incorporation, has been elected president and general manager. FREDERICK H. LOVEJOY will fill the position of vice-president.

OBITUARIES

GEORGE C. BARDONS

George C. Bardons, of Bardons & Oliver and Jos. Dyson & Sons, Cleveland, Ohio, died of pneumonia, after a short illness, on July 29. Mr. Bardons was born in Brooklyn, N. Y., November 24, 1860. Shortly after his birth, his family moved to Hartford, Conn. His father died in the Civil War, leaving a widow and four children. Mr. Bardons started working when he was twelve and a half years old. Machine shops had a strong attraction for him, and when he was fourteen he commenced working for the Pratt & Whitney Co. He was too young to be indentured as an apprentice immediately, but he was placed at work on a milling machine, which he was too small to operate without standing on a box.



He later served an apprenticeship and remained with the Pratt & Whitney Co. until May, 1880. At that time Worcester R. Warner and Ambrose Swasey, two of the contractors there, for both of whom Mr. Bardons had worked, decided to start in business in Chicago. They took with them several Hartford young men, among them Mr. Bardons. The Warner & Swasey Co. remained in Chicago about a year, and then moved to Cleveland. Mr. Bardons was appointed foreman soon after they came to Cleveland. Shortly after this, Mr. Bardons left the Warner & Swasey Co., with the idea of getting a wider experience. He worked awhile for Grant & Bogart, at Flushing, L. I. From there he went to Chicago, and was employed in several different shops.

In the latter part of 1883 or early in 1884 he was offered his former position of foreman at the Warner & Swasey shop, and returned to Cleveland. A few years later he was made superintendent, a position which he held until September 30, 1891, when, in company with John G. Oliver, he organized the firm of Bardons & Oliver. While with the Warner & Swasey Co., Mr. Bardons had charge of the building of the Lick telescope, at that time the largest refracting telescope in the world. On July 1, 1897, Mr. Bardons and Mr. Oliver took over the forging business of Jos. Dyson & Sons. This has since been continued and developed as a separate business.

Mr. Bardons' long and varied shop experience, combined with exceptional mechanical ability and extraordinarily sound judgment, made his advice much sought after and highly valued. A fine workman himself, and with a sympathetic understanding of shop problems and conditions, he commanded the respect and admiration of his associates and employes.

Mr. Bardons is survived by two daughters, Miss Helen C. Bardons and Mrs. Raymond T. Cragin.

Willard C. Lipe, who was prominently connected with the gear manufacturing industry and until recently vice-president of the Brown-Lipe Gear Co., Syracuse, N. Y., died in Tacoma Park Sanitarium near Washington, D. C., on September 4, at the age of sixty-three.

A. Jacobs, president of the American Foundry & Machine Co., Hamilton, Ohio, died September 4. His company has been engaged for many years in making castings for the machine tool industry.

The development of the automobile has been a direct benefit to general business. It has made for an increasing earning power of the country as a whole. These are the inevitable conclusions reached from an analysis of answers to a questionnaire sent out recently by the Packard Motor Car Co., to leading men in various industries.—*Alvan Macauley, President, Packard Motor Car Co.*

TRADE NOTES

Jones Machine Tool Co., Cincinnati, Ohio, used machinery merchant, has moved its office and salesrooms to 528-532 E. Front St.

William P. Stein & Co., tool and die makers of Rochester, N. Y., have removed their plant and office from 282 State St. to enlarged quarters at 424 St. Paul St.

S. & S. Machine Works, Chicago, Ill., are now occupying their new building at 4541 W. Lake St., which affords the company increased facilities for producing special machinery of all kinds.

Winfield H. Smith, machinery manufacturer, announces the removal of his factory to Springville, N. Y., where a new single-story building has recently been completed. The office will still be retained in Buffalo at 10-16 Lock St.

Electric Arc Cutting & Welding Co., 152 Jelliff Ave., Newark, N. J., has placed the agency for "Taperod" electrodes on the interstate steam railways with H. D. Rohman of the R. C. S. Equipment Co., 8 East 41st St., New York City. Mr. Rohman will also handle "Alternarc" transformer welding equipment and "Newarc" accessories and supplies.

Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill., manufacturers and distributors of riveting machines, air hoists, sand sifters and I-beam trolleys, is now represented in Minnesota, North Dakota, South Dakota, Iowa, and the eastern part of Nebraska by the George M. Kenyon Co., Zenith Bldg., 116 E. Fourth St., St. Paul, Minn.

Manning, Maxwell & Moore, Inc., 100 E. 42nd St., New York City, announce the following changes: Percy M. Brotherhood has been appointed consulting engineer; Frank J. Baumis has been made vice-president in charge of the machinery department; and Augustus Wood has been made works manager of the Putnam Machine Co., Fitchburg, Mass.

Dalton Mfg. Corporation, Sound Beach, Conn., manufacturer of small lathes and the Dalton combination machine tool, has retired from business, and is succeeded by the Dalton Tool Corporation, a company composed of and managed by the old employes. The new company will continue to manufacture Dalton lathes at its factory at Willow Ave. and 133rd St., New York City.

Reliance Electric Inspection Co., 449 W. 42nd St., New York City, at a recent meeting of the board of directors elected the following officers: President, H. O'Brien; vice-president, J. D. Whittaker; secretary, N. E. Meyers; and treasurer, A. L. Huestis. Samuel R. Holmgren is no longer connected with the company. Mr. Whittaker, who has been actively associated with the work of the company for many years, will act in the capacity of general manager, and also assume direct charge of the engineering and installation work. N. E. Meyers will continue to fill the position of secretary.

Hoover Steel Ball Co., Ann Arbor, Mich., has purchased the Imperial Bearing Co. of Detroit. The equipment of the latter plant will shortly be moved to Ann Arbor and housed in the Hoover plant. New machinery and equipment, in addition to that purchased from the Imperial Bearing Co., is being added for the production of ball thrust bearings, roller bearings, and ball retainers. The new program does not include the manufacture of annular or radial ball bearings. The personnel of the company remains the same as before, with H. D. Runciman as general manager. S. A. Strickland, manager of the Imperial plant, will be manager of the bearing division. Mr. Strickland has become a director in place of Mr. Dobson who has severed his connections with the company.

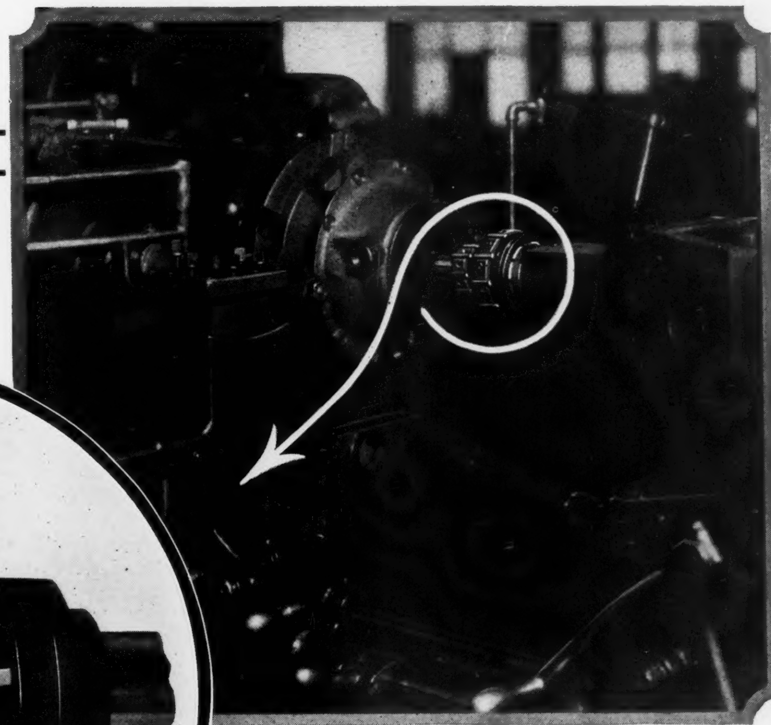
* * *

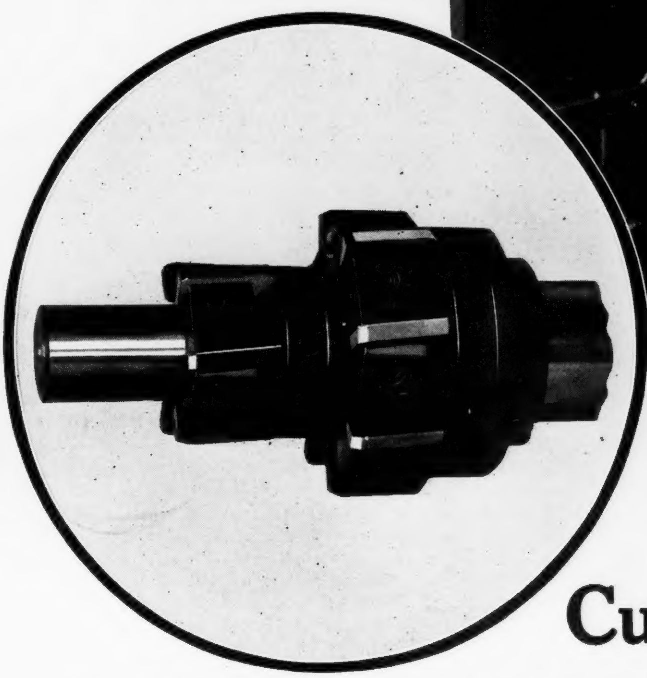
The annual service meeting of the American Society of Automotive Engineers will be held in Cleveland, November 18-19. This meeting will follow the plan used at Dayton, Ohio, last fall, being arranged as a joint meeting of the Society of Automotive Engineers and the factory service managers of the National Automobile Chamber of Commerce. There will be three sessions, all devoted to a discussion of the engineering problems met with in maintenance and repair work on automotive vehicles of all types. Further information may be obtained from the Society of Automotive Engineers, 29 W. 39th St., New York City.

* * *

The Third National Radio Conference for the better voluntary regulation of radio was held in Washington beginning September 30. Two such conferences have been held previously, one in February, 1922, and one in March, 1923, both of which were attended by individuals and organizations interested in radio activities.

At the right, shop view of Wetmore Special Shell Reamer on axle housing job in shop of one of America's largest manufacturers.





Above — Special Wetmore Shell Reamer designed for two operations in one.

How One Manufacturer Cuts Production Costs

ONE of America's largest manufacturers of automobile axles (name on request) saves hundreds of dollars every month by using ***Wetmore Special Shell Reamers*** for two operations in one, as pictured above.

Let us prove to you how *you* can cut costs by using Wetmore Expanding Reamers. Wetmore Shell Reamers are adaptable for both line and pilot reaming. Have 1/8″ per foot taper in hole, enabling them to fit all standard shell reamer arbors. Reamer, lock nut and cone nut are finest heat-treated alloy steel. Left-hand angle blades are staggered to eliminate digging-in, chattering and scoring. The rake of these left-hand angle, high-speed blades assures the reaming of a hole as true and smooth as a ground hole. Shearing effect of blades increases life of cutting edges. Adjustments can be made rapidly and accurately by means of a cone nut at rear of blades.

There is a complete line of Wetmore Expanding Reamers—standard, shell, small machine (5/8″ to 31/32″ inclusive), heavy-duty, and cylinder reamers. *Blades are also carried in stock for all sizes and styles of Wetmore Reamers.*

Write for complete catalog and prices.

Free Catalog!

Write on your business letter-head for the Wetmore Reamer Catalog, showing complete line of standard, heavy-duty, shell, small machine and cylinder reamers. Also arbors and replacement blades. Sent free, postpaid—no obligation to you.

Wetmore Reamer Company

Milwaukee Wisconsin

Manufacturers of Expanding Reamers and Cylinder Reaming Sets, Arbors and Blades.

WETMORE EXPANDING REAMERS

"THE BETTER REAMER"

COMING EVENTS

OCTOBER 10-23—Fall meeting of the Electric Power Club at Greenbriar Hotel, White Sulphur Springs, W. Va. Address of the secretary, B. F. Keith Building, Cleveland, Ohio.

OCTOBER 13-18—Twenty-eighth annual convention and exhibit of the American Foundrymen's Association in Milwaukee, Wis. Secretary, C. E. Hoyt, 140 S. Dearborn St., Chicago, Ill.

OCTOBER 16-18—American Gear Manufacturers' Association's semi-annual meeting at Briarcliff Lodge, Briarcliff Manor, N. Y. T. W. Owen, secretary, 2443 Prospect Ave., Cleveland, Ohio.

OCTOBER 22-24—Production meeting of the Society of Automotive Engineers at Detroit, Mich. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

NOVEMBER 18-19—Service engineering meeting of the Society of Automotive Engineers at Cleveland, Ohio. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

DECEMBER 1-4—Forty-fifth annual meeting of the American Society of Mechanical Engineers in the Engineering Societies' Building, 29 W. 39th St., New York City.

DECEMBER 1-6—Third National Exposition of Power and Mechanical Engineering in the Grand Central Palace, New York City.

DECEMBER 8-13—Exposition of invention at the Engineering Societies' Building, 29 W. 39th St., New York City. General offices, 47 W. 34th St., New York City.

JANUARY 20-23—Annual meeting of the Society of Automotive Engineers at Detroit, Mich. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

MICHIGAN COLLEGE OF MINES, Houghton, Mich. Year book for 1923-1924, containing calendar and announcement of courses for 1924-1925.

CARNEGIE INSTITUTE OF TECHNOLOGY, Pittsburg, Pa. Bulletins containing announcement of courses offered in machine practice, foundry practice, forge practice, and patternmaking.

NEW BOOKS AND PAMPHLETS

ENGINEERING IN AMERICAN INDUSTRY. By Conrad Newton Lauer. 94 pages, 9 by 12 inches. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Price, $2.50.

This book contains a reprint of a lecture delivered before Princeton University on the development of industry in the United States over a period of one hundred and twenty years, and the contributions made by engineering. The book contains much of historic interest to the engineer, and shows pictorially and by means of charts and maps the remarkable growth in the industrial development during that time.

THE STARRETT BOOK FOR MOTOR MACHINISTS AND AUTO REPAIRMEN. 215 pages, 4½ by 7 inches. Published by the L. S. Starrett Co., Athol, Mass. Price, 75 cents.

This is the third of a series of books issued by this company. It is intended to serve as a handbook for motor machinists and automobile repair men. No attempt has been made to deal with specific motor troubles or the peculiarities of particular makes of cars, nor have shop kinks, etc., been included. The whole purpose of the book is to aid the man in the service station or repair shop to gain a better understanding of the uses, methods of operation, and value of machine and precision tools as applied to modern automobile maintenance and repair work.

THE DIESEL ENGINE. By G. James Wells and A. J. Wallis-Tayler. 334 pages, 5¼ by 8½ inches; 139 illustrations. Published by the D. Van Nostrand Co., 8 Warren St., New York City. Price, $5.

This is the sixth edition of a book dealing with the design and construction of the Diesel engine. This book has been prepared for the use of draftsmen, students, and others. The material is divided into ten chapters treating of the following subjects: Origin and Development of the Diesel Type of Engine; the Theoretical Treatment of Heat; Fuels; Balancing; Testing; Air Compressors; and Engine Details. The last chapter contains descriptions of some leading designs of Diesel engines now built for use on land and for marine service, as well as a discussion of the possibilities of use of this type of engine on railways.

NEW CATALOGUES AND CIRCULARS

FLOOR AND STAIR TILE. Norton Co., Worcester, Mass., has issued a series of pamphlets on the various kinds of tiling made by the company for stairs and floors.

ELECTRIC FANS. Buffalo Forge Co., 144 Mortimer St., Buffalo, N. Y. Booklet reviewing the use of electric fans for blowing, exhausting, ventilating, cooling, and drying.

PLIERS. Noble & Westbrook Mfg. Co., 19 Asylum St., Hartford, Conn. Circular describing the new Carlson "super-plier," which serves as a combination wrench and pliers.

HOISTS. Roeper Crane & Hoist Works, Inc., 1720 N. 10th St., Reading, Pa. Circular containing description, illustrations, and tables of specifications covering Roeper electric type R hoists.

LIFT TRUCKS. Revolvator Co., 343 Garfield Ave., Jersey City, N. J. Catalogue for August, 1924, to July, 1925, illustrating four applications of the "Revolvator" lift truck made by this concern.

AXLES. Sheldon Axle & Spring Co., Huck Axle Division, Wilkes-Barre, Pa. Pamphlet entitled "The Next Step in Truck Improvement," describing the construction and advantages of the Huck double-reduction axle.

RECORDING GAGES. Foxboro Co., Inc., Neponset Ave., Foxboro, Mass. Circular entitled "A Champion's Tireless Strength," descriptive of the improved helical tube movement incorporated in Foxboro recording pressure gages.

FANS. American Blower Co., Detroit, Mich. Bulletin 1103, containing a detailed description of the new American H. S. fan, as well as curves covering the characteristics of this fan, specification sheets, capacity tables, and dimension sheets.

CUTTING TOOLS. Diamond Alloy Tool Co., 3620 Summit St., Toledo, Ohio. Catalogue illustrating and describing the line of Diamond alloy production tools made by this company, which includes milling cutters, tool-holder bits, counterbores, etc.

HOISTS AND CRANES. Reading Chain & Block Corporation, Reading, Pa. Leaflet illustrating Reading products, including traveling cranes, chain blocks, electric hoists, and trolleys. A price list is included covering the different sizes of chain blocks.

METAL CLEANER. Cowles Detergent Co., Lockport, N. Y. Handbook entitled "How Science Speeds up Metal Cleaning," containing considerable material on the general subject of metal cleaning, as well as information on the "Esco" cleaner produced by this concern.

POWER PRESSES. Niagara Machine & Tool Works, 637 Northland Ave., Buffalo, N. Y. Circular illustrating some of the styles of presses made by this concern, including horn presses, inclinable presses, double crank presses, trimming presses, and gap squaring shears.

GEAR GENERATORS. Lees-Bradner Co., Cleveland, Ohio. Circulars 39 and 40, illustrating and describing, respectively, the Lees-Bradner No. 5-A gear generator and the Lees-Bradner No. 2 single-purpose gear generator. Copies will be sent to those interested upon request.

RESISTORS. Monitor Controller Co., 500 E. Lombard St., Baltimore, Md. Bulletin illustrating and describing the Monitor edge-wound resistors, which are made in standard units and mounted in frames so that they can be applied in a manner similar to the usual cast-iron grids.

DIE-HEADS. Landis Machine Co., Inc., Waynesboro, Pa. Booklet showing a number of installations of the "Land-Matic" die-head on various threading jobs in automobile, railway, and other shops. Definite production figures are given in connection with the different classes of work.

AUTOMATIC DRILLING MACHINERY. Kingsbury Mfg. Co., Keene, N. H. Catalogue describing in detail the different models of automatic drilling machines made by this concern. The advantages of these machines are pointed out, and complete specifications of the different types are included.

ELECTRIC CONTROLLERS. Cutler-Hammer Mfg. Co., Milwaukee, Wis. Publication 3082, illustrating and describing many types and installations of electric controllers for passenger and freight elevators. One section of the book is devoted to auxiliary apparatus for use with elevator controllers.

TAPPING DEVICES. Geometric Tool Co., New Haven, Conn. Catalogue covering the Jarvis line of high-speed tapping devices, tapping machines, quick-change chucks and collets, and self-opening stud setters. Instructions for operating the tapping devices, and specifications of the various tools are given.

GEARS. Boston Gear Works Sales Co., Norfolk Downs, Quincy, Mass. Circular C3-24, containing specifications and prices covering some new styles and sizes of Boston gears, including helical gears, spur gears, internal gears, miter gears, worms, reduction units, sprockets and chains, and couplings.

PRECISION MEASURING TOOLS. Schuchardt & Schutte, 143 Liberty St., New York City. Catalogue illustrating and describing the line of precision measuring tools made by this concern, including depth gages, micrometers, vernier calipers, microscopes, protractors, angle and twist drill gages, profile gages, optical flats, tachometers, cutmeters, etc.

GEARS. Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Circular 1579-C on Micarta gears and pinions, showing graphically the uses to which Micarta gears may be placed. The pamphlet contains information on the manufacture, design and form of construction of these gears, and gives in addition, horsepower ratings, formulas and tables of gear data.

CONTROL EQUIPMENT. General Electric Co., Schenectady, N. Y. Bulletin 47731, describing briefly the uses and advantages of automatic control equipment. The greater part of the pamphlet contains a list of installations made up to last January, giving the name of the company, station, type of apparatus, kilowatt capacity, and incoming and outgoing voltage.

STEELS. Carpenter Steel Co., Reading, Pa. Catalogue E, containing complete data on the line of tool and alloy steels and forgings made by this company. This book is more in the nature of a handbook than a mere catalogue, as it contains considerable material of general interest relating to steel hardening, annealing, testing, etc. It is bound in dark green leather and contains 269 pages, 4½ by 6½ inches. The material is conveniently grouped into thirteen sections, dealing specifically with the following subjects: Carbon tool steels; high-speed tool steels; special alloy cutting steel; cutlery steels; steels for hot work; steels for cold work; non-corrosive steels; machinery and miscellaneous steels; forgings; cold-rolled and cold-drawn specialty; testing and standard tables and useful information.